Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

Economic impact of shale gas development in the context of energy security of the EU

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, January 4, 2016

Signature

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Abstract

The Thesis aims to analyze the possible shale gas development in the EU in context with raising problem of energy security. Based on the experience of shale revolution in the USA and econometric modelling using the method of Ordinary Least Squares with Fixed Effects to test the dependence of price on shale gas production, the transfer of US model to the EU is discussed. The results show that shale production affects the price negatively and that US model is successful due to multiple reasons, primarily presence of experienced companies, geological structure and strong regulation rules. The Thesis shows the unsuitability of the US model for the EU market. After the first enthusiasm for shale plays research in late 2000s the multiple barriers for drilling have risen up; the most significant are the environmental worries; both on governmental and public levels. US companies have lost interest in the EU and moved to other parts of the world. The shale gas development is not able to affect the energy security of the EU on European, international level.

JEL Classification	F15, F52, Q43, Q47, Q53
Keywords	shale gas, European Union, energy security, shale revolution, energy market, US

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Abstrakt

Práce má za cíl analyzovat možný rozvoj těžby břidlicového plynu v EU v kontextu s rostoucím problémem energetické bezpečnosti. Na základě zkušeností s tzv. břidlicovou revolucí v USA a ekonometrického modelování využívajícího metody Nejmenších čtverců s Fixními efekty k testování vlivu produkce břidlicového plynu na cenu je diskutován přenos amerického modelu do EU. Výsledky ukazují negativní závislost ceny na produkci břidlicového plynu, a jsou předneseny důvody úspěšnosti amerického modelu, zejména přítomnost zkušených společností, struktura podloží a silná regulační pravidla. Práce ukazuje neaplikovatelnost amerického modelu na evropský trh. Po prvotním nadšení pro břidlicová ložiska na konci první dekády 21.století se objevily vícečetné překážky pro těžbu; z nichž nejpodstatnější jsou obavy z dopadu na životní prostředí, na státní i veřejné úrovni. Americké společnosti postupně ztratily zájem o těžbu v EU a přesunuly se do jiných částí světa. Vývoj těžby břidlicového plynu tak není relevantní pro zvýšení energetické bezpečnosti v EU na mezinárodní úrovni.

Klasifikace	F15, F52, Q43, Q47, Q53
Klíčová slova	břidlicový plyn, Evropská unie, energetická bezpečnost, břidlicová revoluce, energetický trh, US

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Acronyms

AEO	Annual Energy Outlook
bn	billion
BOE	Barrels of Oil Equivalent
DOE	Department of Energy, US
EPA	Environmental Protection Agency
EPCA	Energy Policy and Conservation Act
EIA	U.S. Energy Information Administration
EU	European Union
FE	Fixed Effects
FERC	Federal Energy Regulatory Commission
FTA	Free Trade Agreements
GASH	Gas Shales in Europe
GDP	Gross Domestic Product
GSGI	Global Shale Gas Initiative program
LNG	Liquefied Natural Gas
mil	million
MBTU	Million of British Thermal Units
NGA	Natural Gas Act
OLS	Ordinary Least Squares
SOCAR	State Oil Company of the Azerbaijan Republic

US	United States of America
USD	United States Dollar

Master's Thesis Proposal

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Defense Planned:	February 2016

Proposed Topic:

Economic impact of shale gas development in the context of energy security of the EU

Topic Characteristics:

Shale gas represents one of the novel energy sources that might shift the balance of power in economic relations and energy security in the world. Explored and developed in the US, shale gas is found in abundance in many EU countries which might be using it as an alternative to the Russian gas, the process that might result in enhanced energy security in Europe.

This thesis deals with the economic impact of shale gas development in the context of energy security of the EU. It will attempt to look into the economic implications of shale gas development and usage, as well as discuss its impact on the energy security in the EU and Russia.

Various scenarios will be built and tested to produce the results that might be of a special interest both for energy economists and for the policy-makers and stakeholders.

Hypotheses:

1. Exploitation of shale gas in the EU will lead to a consolidation of an energy security of the EU and decrease EU budget expenditures (according to platform "Shale Gas Europe" the shale gas industry in US offered more than 600,000 jobs; also calculation of costs based on data from SGE in Europe and IHS CERA, Chesapeake Energy and Devon Energy in US)
2. Cheap American shale gas can significantly decrease the worldwide price of gas

(data: Bloomerg, PwC, GlobalPetrolPrices)

3. Ineffectiveness of exploitation of own shale gas and separation of the EU can lead to a serious budget crisis in Russia (half of the budget income rises from gas/oil taxes) (data sources: Gazprom, Russian Government)

Methodology:

The theoretical part of this thesis will be based on analysis which draws upon various sources in the research literature. The second, empirical, part of thesis will be based firstly on data collection and secondly on econometric modeling. First-hand data are planned to be collected from the up-to-date EU, Russian and US government statistics (for reserves of shale gas) and statistics of large oil/gas companies (BP, Shell, Gazprom, etc.) to collect price information. These data will be further explored and analyzed. New technologies and competition across the market. U.S. significantly decreased world prices thanks to shale gas mining. U.S decided to allow export of liquefied gas. Boom of shale gas mining in U.S. led to excess of cheap gas at the market, which can decrease prices in Europe in near future. Based on this data analysis the most several econometric models (the most appropriate econometric methods will be used with respect to the data – probably OLS, panel data are considered) will be constructed and applied.

The results will enable the author to analyze the global market situation and predict the behavior of global gas price in near future. Possible impact on Russian and European economies will be also analyzed. For Russian low-profitable Gazprom could be this impact devastating.

Outline:

1. Introduction
2. Literature review: economic impacts of shale gas
3. Energy security of the EU

    3.1 Dependence on Eastern suppliers – statistical data

    3.2 Empirical model testing - own reserves as tool of increasing energy security

4. Methodology and data description
5. Empirical model and its calibrations

6. Main results and discussions

7. References

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Author **Supervisor**

1 Introduction

1.1 Shale revolution

This Master thesis focuses on shifting the balance of energetic transformation, a phenomenon that is recently becoming more apparent but which is yet in the phase of its formation and development but which brings about unprecedented changes to the world market of energy. This thesis attempts to denominate and to analyze the changes in energetics of the US as a result of what is sometimes called „shale revolution“. Moreover, it aims at evaluating the impact of these changes on global energy markets and specifically to measure their outcomes for the European Union energy politics.

The recent changes in energy that occurred over the last 10 years were preceded by the extensive research in the field of searching for effective methods of shale minerals manufacturing. Due to the ecological characteristics of these species (i.e. distinguished by particularly low porosity and penetrability) the traditional method of obtaining hydrocarbons was either impossible or economically ineffective. However, the growth of prices for hydrocarbons that skyrocketed in the 2000s, increased the interest in these minerals and provided hope for funding further research. A combination of advanced methods of well-known basic methods (water ruptures of plays, which was already invented in the US in the 1970s and implemented for the first time by George Mitchell in Texas) led to decisions which (at least in the US) proved to be commercially effective.

As for now, for at least a decade the whole world observes a raging process of further development of this experience. At the same time, every half year the direction of this development changes and application of new technologies is introduced. The surplus of dry gas has led to rapid fall of gas prices in the US. The higher usage for wet gas with high level of (quite expensive) ethane, propane, butane, and gas concentrate became a subject of special interest. Few years ago, the excess of production of these fractions (specifically ethane) compared with insufficient capacity of oil-gas industries also led to decrease in their prices. With these conditions the possibility of effective usage of new technologies for hard-extraction oil resources manufacturing became possible. Shortly, the significant part of oil manufacturing was redirected into this field. As a result of higher effectiveness of basic components of technological process, the extraction of shale gas stabilized even as the volume of total extraction went down. At the same time, re-orientation of released capacity conduced to impressive fast growth of oil extraction (involving the gas concentrate) in the US.

As a result, the transformation of the US energy market led to many consequences. The US is turning from the biggest world consumer and importer of energy sources into an independent "Great Power" in the energy market with the ability to influence the world's prices of energy. In 2014, American coal in Europe is competing with Russian gas, car-owners in South America and Europe are already tanking American gasoline; Great Britain expects to import large amount of LNG from the US (and also to extract own shale gas); Japan is already preparing for excepting American LNG and is developing new technologies of methane hydrations from Pacific Ocean. Meanwhile, we observe higher consumption of coal in Japan, as the gas surplus is expected.

Generally, the "shale revolution" became an accentuated demonstration of more general feature in the new epoch of energy industry. The world started to focus on the development of technologically more robust ways of mining energy resources. This turn seems to be very important for the traditional energy exporters, e.g. for energy sector of the Russian Federation, and particularly for the oil sector of Arctic shelf and oil fields inside the continent, which can be extracted by traditional and conventional methods. These two directions can impulse the development of this sector, however not in short-term (as we observed it in the US), but more strategically and probably in the long-run horizon, considering all possible consequences. At the same time, the simple shift of well-designed technological decisions is insufficient; the new decisions and adaptation of previous ones to more complicated conditions are required.

Therefore, nothing is clear in the world's future energy image. Graphics of business forecasting are usually divided into two parts; left one, where the history is, with high fluctuation, and the right one, where the prognosis is – mostly straight line with steep slope. Rapid changes are not likely to be predicted, fluctuation are never expected. Matters of last decade will probably put an end to this tradition very soon. It is a well-known fact that the last boom of shale gas drilling and badly-approachable oil in the US was not predicted even 10 years ago. At the time when George Mitchell, the "father" of shale gas revolution, sold his company Mitchell Energy and Development to Energy Devon for 3,5 billion dollars (Devon Energy, 2002), US Energy Department still did not see a new tendency behind this big success and evaluated the perspectives of shale gas drilling as a small scale endeavor.

It is well-known fact that recently billions of dollars were invested into LNG import terminals and factories for re-gasification of LNG in the US. Investors of these projects were building the perspective of clear energy future. However, all of them lost. In our days, the investment processes in two main (competing) ways are developing – firstly, the development of LNG export, and secondly, the gas chemistry industry, each of them for billions of dollars. Competitiveness of both these ways was built on long-term expectancies for low gas prices. However, their development began to evolve in other direction. Because of high growth of new sector in energy economy investors are no more likely to take a risk for investments to this field, based on previous non-success of big players.

Two factors in the US are undervalued – bureaucracy and environmental organizations. And these two forces can significantly affect the developing technological revolution. The US government has to solve a dilemma – should it allow exporting LNG to countries (especially China and Japan) through many approved projects led by investors but with contracts with these countries missing? Possibly, the Ukrainian crisis will convince US leaders to sign these contracts and let the export of shale gas to East Asia go freely. The second crucial problem is connected to pipeline Keystone XL[1]. Should administration of president Obama approve this project? One has to consider the fact that large amount of Canadian oil roll-out depends on this pipeline which can seriously affect it. As well as Keystone XL would help the infrastructure of pipelines in the US markedly. These decisions

[1] The **Keystone Pipeline project** is an oil pipeline system under construction, projected in 2008, partially completed, connecting Houston in the US with Hardisty in Canada. To find out more about the Keystone-XL Pipeline project please visit the official webpage, the link is provided in the part Bibliography.

will influence the orientation of further progress. To all these factors one can also add the beginning of concessions emission for export of light oil from the US (after 40 years prohibition).[2]

So far, there is no clear evidence about the capacity of economically effective resources of hardly-extractable oil in the US, and researchers have not established the future of this oil and shale gas. No one knows whether the fall of extracted amount should come around 2020 or long after that. One more problem is related to the environment – the regulation of realization of hydro-rupture of plays. Majority of environmental issues in the US are in the State of New York, where are large supplies of shale gas at well Marcellus (Ivanov, 2014), but they are not realized because of shale gas drilling moratorium from 2008. Over the years experts try to analyze all aspects, but they still have not found a unified solution. As a result, there will be probably realized regulations for shale oil and shale gas drilling, which will make these methods economically ineffective.

It is already clear this tendency is getting progression – more states are actuating the stricter rules of hydro-rupture process, and the US federal government is following initiative and is issuing own regulations, which makes the whole situation even more complicated. Both US civil society and government are trying to estimate the future in energy in the US. Two sides of the coin are considered – either the US will become energetically completely independent country and it will contribute to US economy positively, or we become a "green" country, which tries to preserve the environment. As we will see later, the European Union prefers the second option. In comparison with the EU, the Barack Obama's administration has not confirmed which direction the US energetics should go, how to unify these two different approaches to shale oil and gas, and has not offered its own solution, which would be most suitable for all political, economic, social, and environmental fields. And not only US companies are waiting for this solution – many countries around the world are in the same position.

[2] Due to **Energy Policy and Conservation Act** (EPCA) (link to Act is provided in Bibliography) from 1975 was applied ban for crude oil exports except in select circumstances. EPCA was reaction to 1973 oil crisis and it was designed to reduce energy demand, increase energy production and provide energy efficiency in general. In June 2015, the export of light oil to Mexico was permitted. On 18th December 2015 the US Congress lifted ban from 1975.

This indeterminacy is partially linked to development of technologies in other industry sectors and other regions. For as long as the renewable energy resources will not be totally economically effective (or their subsidiary by government or society will not be lower), the oil and gas will still be in high demand. Moreover, geopolitics experienced shocks in recent years. The “Arab Spring”, Iraq, Syria, Iran, and Ukraine – no one knows in which part of the world one can expect the political transformation next. If the changes are so rapid and unprecedented, what should one expect at geopolitical map of the world in a few years? The forecast of this evolution of recent situation is very complicated. For the European Union everything happening in the world’s energy market is very important – both economically and politically. And concrete image of our future depends on many factors, which involve our ability to follow world’s tendencies and to react to them adequately.

1.2 Energy market uncertainties

Shale gas represents one of the novel energy sources that might shift the balance of power in economic relations and energy security in the world. Explored and developed in the US, shale gas is found in abundance in many EU countries which might use it as an alternative to the gas imported mainly from the Russian Federation, the process that might result in enhanced energy security in Europe.

The political aspects are crucial for future of energy market in the European Union. In the first half of 2014, the state of affairs has changed in connection with Ukrainian crisis in context of supplying energy to the EU. Russian Federation is at odds with the Ukraine about the natural gas and there is significant risk the delivering of gas through Ukrainian pipelines to the EU will stop at any moment. Therefore, in May 2014 the EU together with US started to work on first contracts, which should allow US exporters to sell US shale gas to the EU customers. On the other hand, Algeria is aware of power of shale fields, advantage of location (near the EU) and developed infrastructure – Algeria has LNG terminals on the coast and theoretically is ready to transport shale gas to the EU. Therefore, Algerians are planning to explore all known reservoirs already this year. In fact, Algeria can be the most predominant player in the energy market of the EU and possibly it can be the biggest supplier of natural/shale gas to the EU.

Generally, hale gas is a product of groundbreaking technology which helps to realize American dream, which seemed to be unapproachable not a long time ago – to get out of energy dependence. Natural gas from unconventional resources (i.e. from black mineral shale) is being already mined in capacity, which allowed to US intensely reduced import of liquefied natural gas (LNG), and in near future the U.S. gas will be fully exportable. Already all attention is paid to decreasing of oil import in US. Energy independence of North America becomes real horizon.

Therefore those who are familiar with the term “shale gas” usually ask two questions: is not this topic just an overvalued inflated bubble?; and how drilling of shale gas will affect supply of gas on world market? The answer to the second question is simpler than to the first one. Already in 2010, US started to export small amount of shale gas in form of LNG to Europe for probation. U.S. sold this gas in Europe for price lower than price of Norwegian and Russian gas which led to small (but significant decrease) of stock prices of major producers of gas in these two countries. After this event the demand for long-term contracts with gas exporters of Norway and Russia decreased and new customers began to deal the conditions of contracts more in detail. Period of unrealistic threat for main energy suppliers in Europe passed away. The world’s market of energy is changing; all big players in oil and gas market have to adapt to new conditions settled by US to lower the loose, and to find the solution how to react to this challenge. Apart from that if it is bubble or not, if it is only the short-term fluctuation or long-term tendency, the development of own technologies how to mine and sell gas (natural or shale) in cheaper way seems to be necessary. The current situation can be also regarded as incentive for renovation of all used technologies to remain competitive.

In context with energy security of the EU, there are many uncertainties regarding EU directive “20-20-20” (the EU growth strategy for one decade), which proposes to approach 20% of renewable resources used in energetic, decrease by 20% emissions which lead to greenhouse effect and to increase by 20% effectiveness of energy usage, before 2020. European politicians are asking now, why ecological targets are more important than economical and social, why nobody asks to improve well-being of society by 20%. (Europe 2020, 2010)

The question is not so hollow. Actually, Europe is starving because of lack of energy. And when consumers in the EU found out that it is cheaper to buy US coal than Russian gas, at the time when old coal power stations started to being renovated, the new logical question took place. Why not to use own coal? Even not as pure as American coal, but easier to access, and cheaper? At this moment the request for environment-friendly economics of the European Union began to be a barrier for energetic regeneration of European economy. Largest European economies began to asking themselves, if the low-coal politics is indeed needed. The answer to this question is so far unclear, and nobody in the EU is willing to refuse to follow unrealistic climatic aims.

In 2012, the environmental department of the European Union issued 300-pages long report (Broomfield, 2012) about negative influence of substances, which are used in process of shale gas drilling, to human health and environment. This threat is more significant than consequences of all other types of fuels. At the same time, this field is not regulated by the EU. Therefore, environmental department considers necessary to regulate this sphere. According to authors, the negative consequences of shale gas drilling could be observable in the quality of air, ground and underground waters. Hence the shale gas drilling using U.S. technology should be allowed only in that places where underground water is not used for drinking.

The European Union issued at the same time several reports (European Commission, 2015) dedicated to shale gas problematics. In one of these reports is said that shale gas drilling will not affect the gas market in Europe at all. It looks like the damage of environment in shale gas drilling is designed only for the EU. France, where is one of the biggest shale field in Europe, already banned all possibilities of shale gas drilling on its territory. Poland tries to attract investors by various instruments, but the investors are skeptical, e.g. the ExxonMobil left Poland in summer 2012. The solution of the EU is not likely to solve problems, but as it appears, can make them worse.

This thesis deals with the economic impact of shale gas development in the context of energy security of the EU. The shale gas is “hot topic”, which has changed the map of energy world in last decade and has started multiple discussions on world level. After the shale revolution in the US the economic debates have started, whether this model can be used also in other parts of the world. The economic implications of shale gas development and usage will be considered, as well as discussed their impact on the energy security in the European Union. Few scenarios will analyzed to produce the results that might be of a special interest both for energy economists and for the policy-makers and stakeholders.

In comparison to an existing stream of literature this thesis has two main goals. Firstly, to show that shale gas by itself may not be such economically profitable as was originally supposed but together with shale oil is highly economically effective to be drilled, with profit for companies for the lowest price around 2 USD/MBTU (mil. of British Thermal Units). This thesis confirms that the US shale model is sustainable in the long term, and the price for final consumers is negatively affected by increasing shale gas production. Secondly, since the topic is recent and just a few papers were dedicated to shale gas in the European Union, it provides the most updated view on shale gas as a possible tool to improve energy security in the European Union. In 2010, after profitability of shale gas revolution in the US was confirmed, the governments and producers in the EU started to bring to attention the shale gas production in Europe. Together with this enthusiasm several studies were published. Since the situation has changed significantly and nowadays in 2015 the situation in Europe is totally different, this thesis brings a contemporary overview of shale gas future in Europe. Based on the estimations of major European producers and government reports the thesis aims to show that economic efficiency of shale gas production in the EU is rather speculative. Keeping in mind the environmental issues and social aspects, this thesis proves that shale gas production would be applicable only for some regions (the UK, Hungary) and no general exploitation on the EU level is possible.

This thesis has a goal of verifying the following major hypotheses:

- Exploitation of shale gas in the US states has led to lower residential prices has reduced final costs for households.
- US model of shale revolution is transferrable to the EU.
- Exploitation of shale gas in the EU would have serious negative ecological impacts, particularly for the quality of subterranean waters.

Thesis is divided into 9 chapters including Introduction and Conclusion and each of them is divided into subchapters for better orientation in the text.

The second chapter (the chapter that follows the Introduction) provides the overview of the research literature on the topic. Theoretical comparison of various papers dedicated to shale gas efficiency and energy security in this context is introduced. Both the world's and EU's energy markets and the implications for both of them are discussed.

In the third chapter, the shale gas drilling itself is introduced. After short view on technological issues and historical perspective the current world situation of shale gas reserves and drilling is described.

The US shale gas market, as the case study in this thesis, is narrowly analyzed in the fourth chapter. Since the shale gas is widely used particularly at the US territories, the data for the US market are crucial for studying the efficiency of shale gas implementation.

In the fifth chapter, the current EU situation is described. Potentials of shale gas drilling in all the EU countries is discussed and corroborated by the current data. Also, the possibility of shale gas import from non-EU countries is considered.

The sixth chapter discusses the differences of economic and technological conditions for shale gas drilling in the US and in the EU.

The seventh and the eighth chapters are dedicated to the empirical model itself. Firstly, the methodology, data and hypotheses are described. Secondly, the model is described and results of model are discussed an implications are drawn.

Finally, the last chapter concludes the thesis. It summarizes all parts of the thesis, comments on the predictions of possible development on EU energy market, draws conclusions and policy implications, and suggests recommendation for further research.

2 Literature review: economic impacts of shale gas drilling

The purpose of this chapter is to provide a summarized overview of the most relevant literature to shale gas revolution in the US and its possible application on the EU market. The US shale revolution happened very quickly in terms of transformation of energy market and significantly changed the way of understanding the world market. After the shale miracle had taken place in the US, economists immediately began to observe economic changes and impacts on the US economy, to make predictions for the possible development and to discuss possible devolution of the US technology to the EU conditions. However, since the topic is highly recent, not many relevant studies regarding shale gas are available, specifically for the EU environment. The summaries and comparison of s relevant papers dedicated to the topic is provided below. Since the topic is highly contemporary, the space for contribution is large and researches with focus on many sub-topics corresponding to theme are likely to contribute in the near future.

2.1 The United States

Despite the majority of papers are dedicated to shale gas production in the US, only the most relevant were chosen to be discussed. Shellenberger et al. (2012) tracks the timeline of development of energy industry in the US, targeting the role of government in the process of shale revolution. They notify that despite the shale gas production has already been growing since 1980s, the hydraulic fracturing methods were not used almost till the end of 1990s. After the US government had approved usage of this technology for commercial reasons in 2002, the shale gas revolution began. From the study of Shellenberger et al. (2012) one can take that the government support (either through legislation or financial measures) may be crucial for a shale revolution to take place, regardless of a country.

Ivanov (2014) provides one of the most detailed analyses of the US shale gas market, with the emphasis on its economic efficiency. The up-to-date comparison of statistics of several US market leader companies is performed. Ivanov (2014) points out that shale gas drilling is not very economically effective by itself, compared to the natural gas drilling using conventional methods, however shale gas oil makes it profitable. Based on the data covering 3–5 years of different mining companies Ivanov (2014) proves that shale oil drilling is highly profitable and economically reasonable, and shale gas is drilled mostly due to its presence together with shale oil.

The initial euphoria for shale gas drilling have subsided and the number of shale gas wells decreases every year; instead the number of shale oil wells increases and the shale gas is being mined as a supplement.

More interesting point of view is provided by Gény (2010), who looks on all the changes which occurred in the US since 2000, both policy and market changes, and finds five catalysts, which stand behind the US success.

2.2 Application of the US methods abroad

According to Stevens (2010) the technology used in the US cannot be applied in the rest of the world because the American companies have a lot of experience with oil and gas mining, the US energy industry was ranked among the largest in the world and companies did have enough financial instruments for further investments. At the same time the increasing demand for oil and negative trade balance were incentives for research. Ivanov (2014) agrees and discusses the changes oncoming in the US energy sector that influences the global market. He does not dispute the fact that shale gas revolution significantly lowers the world price of oil and gas (however he stresses the long-term influence), but at the same time he doubts that “American miracle” can happen in any other country. Stevens (2010) also looks more into the future and discusses the consequences of potential cheap gas dominance on the world market as a result of spreading gas drilling using unconventional methods. He warns against “*serious gas shortages in the medium term*”, based on the assumption that according to his data there are five times more proved reserves of shale gas than conventional gas but its exhaustion can happen much faster.

Companies willing to invest into energy market worldwide are facing the decision they have to make – conventional or unconventional. Two problems arise from investor uncertainty at gas value chain, according to Stevens (2010). Firstly, due to shale revolution during the last decade the market price fluctuated more than before. Additionaally, the investment into gas research and drilling is likely to be lower than it would be if the shale revolution in the US were not to happen. Second problem is caused by evolving climate changes. Stevens (2010) warns that if shale gas is to show the profitability in long term, the willingness of investors to focus on relatively expensive technology for production of energy with lower carbon emissions will decrease.

Ivanov (2014) also dedicates part of his book to the US-Russia relations and analyzes the US shale gas revolution in light of the interests of the Russian Federation. In relation to events, which can lead to restructuralization of world energy market, he makes suggestion for Russian government and leader companies to start with development of their own shale gas drilling technologies as soon as possible and do not lose contact with global leaders when the change occurs.

2.3 Shale gas revolution in the European Union

Majority of authors claim that the transformation of the EU market in general is not possible. The reasons why the US model cannot be applied in the EU are partially described by Gény (2010). He noticed that land access restrictions and high costs are two pivotal reasons why there is no possibility of quick shale revolution in the same way as it has happened in the US. According to Gény (2010) the transformation of market to unconventional sources of energy, particularly shale oil and shale gas, is a "*long-term story and is unlikely to become a sudden gas revolution as in the US*". He provides several reasons, why the production of shale gas cannot start (or at least will not be "*significant*") within ten years; concretely low drilling investments, lack of geological knowledge of European mainland, almost no data for proved reserves of shale gas and oil plays in the EU, high regulation and several other specifics. Stevens (2010) agrees with Gény (2010) and thinks that Europe will not be able to either accept American model or develop its own. As the main arguments for this statement he brings the unwilling public acceptance, and problematically specified law, which designs that all profit devolves not to private owners of land, but to state governments.

Gény (2010) analyzes the potential of the US technology applied on shale gas drilling for development of unconventional gas on European energy market and transformation of this market to a completely self-sufficient one. The implications of the US system are studied with understanding of the EU conditions and recalling the history of European energy market. Gény (2010) agrees that the US model cannot be applied on the EU market and states the need of development of European own technologies and business model. He suggests several points which should be implemented in the European energy system if the EU will would like to transform to unconventional methods in the future. According to Gény (2010) the financial incentives of governments for research should be introduced, completely new approach to drilling, using less wells and different technologies, using lower amount of water and providing prospects of deeper wells. Due to high reluctance of local inhabitants the financial compensation would probably need to take place, making the drilling itself less economically effective.

Johnson and Boersma (2012) made short study with questions opening the discussion whether shale gas drilling can be considered as an alernative in the EU using the US methods, but did not provide any sufficient answers. Shadurskiy (2011) explains why the shale gas discussions in the EU are more politically-based, rather than economically. Shadurskiy (2011) also analyzes how the US energy market changed in last decade and reasons of success of the shale revolution and doubts the economic reasons are valid for its duplication in the EU economy.

2.4 Poland as the case study

On the case of Poland Shadurskiy (2011) shows that despite the total transformation of the EU market is not possible in general, single attempts to produce own shale gas can significantly change the market structure on regional level. In comparison, Johnson and Boersma (2013) made a case study of Poland based on researches both in the US and the EU to discuss environmental issues in the first place, and economic aspects of potential shale gas drilling. According to Johnson and Boersma (2013), Poland was chosen as the one of the major applicants for possible transformation of energy market using unconventional methods. The debate on political and social barriers, which has to be removed before the actual production can start, is initiated with no concrete predictions.

2.5 Environmental issues

Broomfield (2012) provides the critical report on environmental issues coming from hydraulic fracture methods, published as the document of the European Commission, and understood as official position of the EU. This study was written for supporting those European countries, whose governments were not convinced by the techniques used for shale gas drilling in the US, particularly pointing out the environmental respect. In his paper, Broomfield (2012) props oneself upon the several US studies analyzing environmental impacts of shale production, and legislation regulating hydraulic fracturing, such as documents from the US Environmental Protection Agency (EPA) or the Natural Gas STAR program. Broomfield (2012) showed that constructive standards had to be made before the mining was able to start. Another study published by EU officials, specifically the European Commission, is report written by Pearson (2012), who also considers the consequences of shale gas drilling in the EU, with stress on environmental issues. The study admits the possibility of local shale gas production, however does not see the shale revolution as probable to happen in the EU on a large scale.

According to Broomfield (2012), high attention to technology using hydraulic fracture should be paid by the European Council. He pointed out that many member states may be interested in possibility of shale gas research, however several of them already introduced legislation, which prohibits hydraulic fracturing methods due to water pollution anxiety. At the end of his paper, Broomfield (2012) agrees with restructuralization of energy security in the EU, but at the same time asks for formal regulations of present methods and suggests to develop own environmental-friendly technology. Jacoby, O'Sullivan and Paltsev (2011) show that technology used in the US model makes positive impacts on economy, energy stability, and also environment. They particularly analyze air pollution and conclude that increasing shale energy can lead to up to 50% reduction of emissions. However, Jacoby, O'Sullivan and Paltsev (2011) noted that safety and storage techniques should be modified.

To conclude, papers summarizing the US energy market are more optimistic. According to majority of authors, the potential of the US shale gas resources is high and economically profitable. On the other hand, the papers dedicated to the European market and prediction of shale production on the territories of the EU are rather pessimistic. Due to various environmental issues, regulations and lack of investments to this industry, the universal transition to shale gas is highly improbable. However, authors do not exclude local production which can change energy market on a regional level.

3 Evaluation of shale gas drilling development

EIA estimates world unconventional gas[3] reserves at 331 trillion cubic meters[4], but estimations for the real amount which can be drilled, are uncertain. According to EIA estimations from 2013 (EIA Annual Energy Outlook, 2013) there is about 208 trillion cubic meters of shale gas and EIA predicts that 7% of all natural gas production will have origin in shale plays by 2030.

The biggest (and in commercial sense we can say “only”) producer of shale gas is the US, in cooperation with Canada, through the common system of pipelines. Shale gas plans are discussed in all parts of the world, mostly in China, Argentina and the EU. Shale gas already forms 47% of the total consumption of gas in the US (EIA Annual Energy Outlook, 2015) and due to shale success in 2009 the US overtook Russia in the list of the biggest natural gas suppliers. It affected the US price of natural gas, which will be shown later. As we can see in Figure 1, the natural gas price in world terms is highly unstable, but tendency of decreasing price is observable. In the EU the acceptance of the technology and its utility is subject of discussion by government representatives individually across member states and therefore the approaches to the shale gas drilling vary greatly. Public opposes the technology mainly due to environmental issues.

[3] Unconventional gas is: shale gas, methane from coal plays and gas in other mineral forms
[4] The estimated world reserves of conventional gas are 421 trillion cubic meters (EIA, 2014).

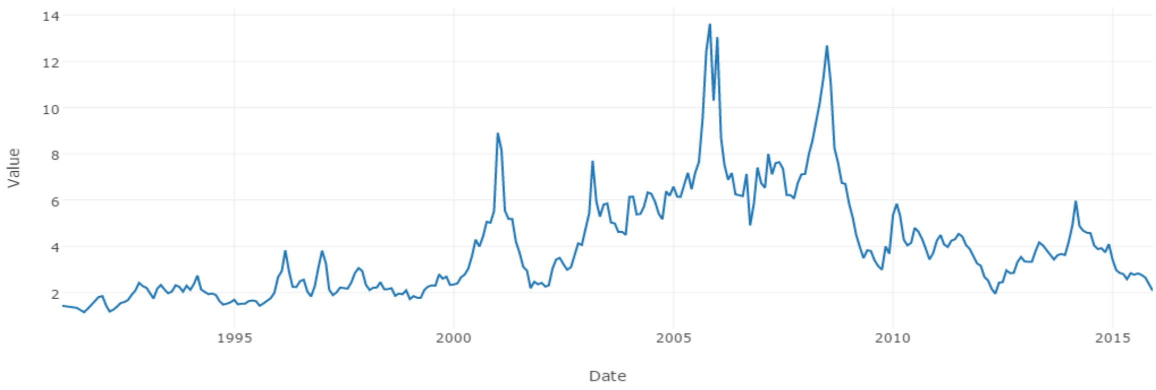

Figure 1. World average price of natural gas, USD per thousand cubic meters

Source: Henry Hub Natural Gas Price

3.1 Technology

Shale gas drilling is technologically difficult. Shale gas is present in shale rock slices, which are situated 400–4000 meters under the ground. The rock does not let the gas escape, thus it remains inaccessible for widely used classical gas-wells, in contrast to the fields with natural gas. Miners use a combination of technologies to harvest the gas. It consists of drilling of long horizontal wells and making fissures in the rock by pressed water with sand.

Shale minerals are located more often in horizontal slices (parallel with surface). Classical vertical wells reach only small part of shale and therefore are inefficient for drilling this type of gas. In shale gas drilling it is necessary to drill long well inside of shale slice because gas can only be drilled in narrow surroundings of well. Miners use combination of wells for shale gas drilling. At first vertical wells are drilled, and afterwards they are followed by horizontal wells. It is not enough to create the well itself because the amount of leaked gas would be very low. That is why the hydraulic fracturing method is used – water together with sand and chemicals is pumped into the well and creates high pressure inside of the well, which causes scratches. Leaking gas is pumped to the surface together with water.

It is obvious that it is necessary to use special heavy machinery for drilling. That is not just the drilling ring itself, but derrick with platforms, special pumps, gastanks, reservoirs for sand and water, and the drilling deliveries as well. That increases initial fixed costs. Drilling is complicated by the fact that gas fields are usually located in badly accessible areas, coupled with no road access. This method did not get under control successfully until 1990s in the US.

3.2 Current reserves worldwide

According to the EIA statistics, which publish the estimations of reserves worldwide, the largest shale plays are located in Siberia, North America, Argentina, Brazil and South-Eastern China. In Table 1 are listed 10 countries with largest reserves of shale gas, according to EIA (2013). However, beside the US, the shale gas has not been drilled for commercial reasons in any other country in 2015. In some countries the exploration wells were initiated (the most notable works were done in China), in others they are being initiated subsequently or are planned in the near future (Argentina, Libya, Algeria). Despite facing the problem of competitivness of Middle Asia countries (Mejstřík & Chvalovská, 2012), Russia does not plan to drill shale gas in near future at all because there is no government support of unconventional methods and Russia is still able to drill natural gas by conventional methods with lower costs. It is not expected that Russia will start with exploration wells at shale plays before any signals of shrinking of natural gas reserves will be circulated.

As a consequence, this chapter discusses the overview of only few countries with largest reserves (and potential for drilling) – China and Argentina. The shale gas situation of Azerbaijan is analyzed as well in this chapter because Azerbaijan could be considered as possible shale gas supplier to the EU, due to its location. The situation in the US will be discussed in next chapter and Algeria will be analyzed in Chapter 5.

Rating	Country	Trillion cubic feet
1	China	1115.2
2	Argentina	801.5
3	Algeria	706.9
4	US	622.5
5	Canada	572.9
6	Mexico	545.2
7	Australia	429.3
8	South Africa	389.7
9	Russia	284.5
10	Brazil	244.9

Table 1. Estimated unproved technically recoverable reserves of wet shale gas (2013)

Source: Own table, based on EIA data

3.2.1 China

Despite the production of shale gas is still very low China possesses probably one of the largest reservoirs of shale gas in the world, with estimated 31.57bn m^3 Compared to the estimated reserves of 24bn m^3 in the US in 2012). (EIA Annual Energy Outlook, 2014) However, the amount is not the only factor for comparison. Initial exploration wells showed that shale plays are 1500 – 4000 m underground (compared to 800 – 2600 m in the US), and the majority of the largest plays – Tarim Basin, Junggar Basin, Ordos Basin and others – are located in remote mountains or dessert areas, requiring costly infrastructure with pipelines to be built. (EIA Annual Energy Outlook, 2013) At the same time, a lack of water for hydraulic fracturing in these areas might be a problem, which can also raise prices of final product. In comparison to tedious bureaucratic approaches of European governments regarding hydraulic fracturing, the Chinese government considers the support of shale gas production as highly desirable. Drilling companies are subsidized by lower tax rates, support of technologies development and lower customs for machines. Research is aimed at exploration for water subsidy for water. Private companies do not have chance to outrun the competition because only state companies – CNPC, Sinopec and China United Coal Bed Methan are subsidized. According to the Chinese plan of shale gas production there should be 6,5bn m^3 of gas drilled in 2015. This might be an ambitious plan because only 0,2bn m^3 of shale gas was produced in 2013, while the total consumption amounted to 150bn m^3. (EIA Annual Energy Outlook, 2014)

Another interesting fact is that China massively invests into the American shale gas production – Sinopec bought 33% share of the US company Devon Energy, CNOOC bought Nexen with shale gas plays in Canada, and PetroChina owns 49.9% of shares in Duvernay project for shale gas production in Canada. (BP Statistical Review of World Energy, 2015) It can be expected that China will try to get cheaper gas via import due to significantly increasing natural gas consumption. Considering the current data it cannot be expected that China will initiate significant production of shale gas in the near future.

3.2.2 Argentina

On 30th October 2014, government of Argentina endorsed reform legislation on hydrocarbon production, which should help the country in effective development of the shale gas production and replicate the success of the US in this regard. The new law extends drilling licenses and lowers the level of minimum investments; companies also receive partial freedom in import controls and capital flows. (EIA Annual Energy Outlook, 2015) Specifically, Argentina aims to attract foreign investors to Vaca Muerta plays. Vaca Muerta is the largest and most perspective shale gas playing, discovered in 2011 by state company YPF. Unfortunately, it is disputable whether this law would be enough to promote usage of the technology since Argentina is not sought after economy for investments due to active role of government in the sector.

According to the Ministry of Energy, Argentina had reserves of 21,9 bn m^3 in 2014, which were the third largest reserves after China and the US (EIA Annual Energy Outlook, 2015). On 16th July 2014 the biggest Argentinean oil company YPF announced conclusion of a contract with the US company Chevron regarding the joint production of shale gas on Vaca Muerta plays. Chevron is expected to bring an investment of 1.5 bn USD. On 28th August 2014 YPF signed contract with Petronas, with investment of 475 mil USD. Argentina also considers cooperation with Russian companies, Gazprom CEO Alexey Miller visited Argentina for negotiations in October 2014 but no concrete agreements were concluded. In the end of 2014, the researchers began to work (led by YPF) with not clear prognosis of future development. (BP Statistical Review of World Energy, 2015)

3.2.3 Azerbaijan

Azerbaijan plans to start to work on shale gas plays before 2020, according to SOCAR (State Oil Company of Azerbaijan Republic) representatives. (Socar, 2015) There are several perspective territories in Azerbaijan where the geological investigation can be set – particularly in Gobustankii and Shemahinskii regions. In 2015 SOCAR initiated discussions on the possibility of shale gas mining with several well-known foreign companies. These companies (specific names were not published) should accomplish exploration of wells by 2020 and afterwards effectiveness of drilling will be evaluated by local government. (Socar, 2015) The news has not gone unnoticed at the local energy market – not just in Baku but also in many other countries. Azerbaijan is one of the significant players in the international energy market, therefore any news about the country is welcome by public. At international conference Caspian Oil & Gas 2015 Khoshbakht Iusifzad, vice-president of SOCAR, stated that shale gas revolution in Middle East is not a fantasy anymore but true reality. Progressive technology of hydraulic fracturing allowing drilling oil and gas from shale plays has considerably re-shuffled the international energy market, which appeared to be stable forever.

However, in case of Azerbaijan this information might be misleading – shale gas technique is still risky and ecologically doubtful, while in Baku there are large plays of natural gas and oil with old conventional drilling technology on hand. Additionally, the fact, that Azerbaijan, for which shale gas revolution might not be economically effective (shale oil and gas can lower the prices of traditional oil and gas – the main exporting items of country), gives an indication for this revolution, be worth mentioning. This can be highly effective favorable in long-term. If the revolution cannot be stopped, then it is valuable to actively participate in it.

3.3 Role of environmental issues

Environmental issues are one of the most significant barriers to shale gas production expansion worldwide and as is described later, the most "common" barrier in the EU. Before some of the main environmental effects of hydraulic fracturing methods will be described, it should be noted that there is no clear evidence of environmental impacts of unconventional method of drilling in the world. These activities have been the topics of both academic and technological journals but no harmful effects on health or negative effects on the environment as a result of hydraulic fracturing were detected or proved.

Impacts on environment may play the most important role in shale gas drilling, particularly the method of hydraulic fracturing of shale massifs using chemicals, water and sand, which contains the risk of underground water contamination. The issue is apparent in the US and that is why US government representatives already started drafting legal standards. For example, the parliament of the state of New York has already prohibited using hydraulic fracturing of shale rocks on its territory. This regulation will stay valid until the safety of the new shale gas drilling method is proved. Lastly, West Virginian representatives have issued regulation significantly constraining possibility of shale gas drilling (EIA Annual Energy Outlook, 2015).

Within the space of the European Union, there have been few notable studies of the environmental impacts published since shale revolution in the US. In 2012, The Royal Society and The Royal Academy of Engineering (2012) published environmental study, which concluded that the regulated hydraulic fracturing *should* be safe. The paper analyzed possible impacts of hydraulic fracturing on groundwater and its contamination, well integrity, risk of leakages of gas, climate affects and chemicals used in shale gas drilling. It also provides technical aspects of all risks – environmental, health and safety risks and concludes with the approval of shale gas drilling, since no significant issues are detected (when following all current regulations and directives).

However, in 2014, a new British study with opposite conclusions was published. According to Walport & Craig (2014), main British government science consultant, mining method called „hydraulic fraction“ plays the same risk as it was observed in the past at scientific and technical innovations like asbestos, tobacco or insurant thalidomide. Walport & Craig (2014) show the examples of innovations, which were broadly accepted precipitately and did have negative consequences on the environment and human health conditions. For example thalidomide, agent used in 1950s and 1960s as a medication preserving pregnancy sickness, was later discovered to cause higher probability of child limbs deformation. Walport & Craig (2014) claim that in all of these and many other cases the late acknowledgement of negative effects does not depend only on health conditions or environment, but also on massive expenditures and competitiveness lowering of companies and public economies following the wrong path. This can also be the case for hydraulic fraction. The study warns against contamination of ground water in the area of shale gas plays and points to the negative aspects of increased truck transport in the agricultural areas. Walport & Craig (2014) support the idea of solving the increasing energy demand only by renewable resources; however this goes against the interests of the sector.

Broomfield (2012) published official environmental study for the European Commission. Study reviewed all of the available information and was based mainly on the experience from the US. It identified a number of potential risks and issues presenting high risk for the EU inhabitants and the climate environment. The study stated water contamination risk and air and noise pollution due to high traffic level as two major risks. According to Broomfield (2012), hydraulic fracturing is activity with significant risks for human health and environment. Some of the impacts could turn into long-term and global problems (e.g. a massive explosion on the shale gas well in Chesapeake plays in Pennsylvania in April 2011). The rupture on drilling pipeline caused the leak of toxic water with chemicals into surroundings and 38 000 liters of water contaminated fields and a river. The long-term consequences of this accident are still unknown since the area has not been cleaned yet.

4 Case: “Shale revolution” in the US – suitability of this model in the EU space

4.1 Introduction

The US became the biggest producer of gas in the world in 2009, as a result of the development of shale gas drilling.

American shale gas boom has the changed world energy market. Gas market in the US was saturated already in late 2000s, domestic prices fell down and unused gas was transported as LNG to Europe. This led to a decrease of prices on European spot markets but at the same time the need for gas export in the form of LNG was created in the US. Projects of building new import terminals started to be considered as unnecessary and were changed to projects of building new factories for manufacturing of gas and export terminals of LNG. Federal authority has started to issue permissions for these projects. According to EIA statistics (2014) the shale industry has created around 2.1 million of direct or indirect job positions.

World energy market is changing. Many countries (consumers of natural gas) have tried to recreate American success in the past several years and have focused on their own unconventional gas resources. Meanwhile the development of new technologies was supported in the US and was extended not only to gas-drilling but also to another energy sectors. New factories producing mineral fertilizers and plastic materials were built, companies are transferring their own consumption from coal to gas and large projects creating production of liquid engine gas fuel, gas-to-liquids (GTL) has began to be developed[5]. Fuel type of public transportation such as buses, cruises, taxis and road-trains is also considered to be changed to gas-fuel. Abundance of cheap gas creates new demand.

Market participants are obliged to admit that the US shale gas revolution took place and the consequences are long-term and irrevocable. Sellers and consumers of

[5] For more information about GTL production please see official Shell website, link is provided in Bibliography.

energy have no more hope for escaping this bubble and everything will remain as it was before. The producers of plastic materials for oil drilling became involved shortly after shale gas miners. As a consequence, countries of North America have chance to become fully energetically independent already in this decade, possibly till 2020.

Ideas of freedom and independence are traditionally important for US society. That is the reason why the idea of full energy independence is so popular. It is not likely to be abandoned now even if the US eventually recognizes some mistakes or discovers inaccuracy of assumptions. If the technologies of shale-gas drilling meets unexpected economy or ecology barriers, it is presumable they will be replaced by another technologies. So strong public demand, which we can see on the US market, cannot be left unsatisfied and be neglected without offering another alternative.

Possibly, American ideas and technologies of adapting unconventional resources of natural gas will find more effective application in other countries in near future but in this particular case the experience of the US shale gas market participants has to be analyzed and studied properly. Current level of globalization of energy market will be always connected to shale gas boom in the US.

The geology of each shale gas resource varies and so does performance of wells. In the US, the production of shale gas wells is invariably increasing in large amount of gas wells because of the higher precision and efficiency of horizontal drilling and hydraulic fracturing in gas extraction. Many producing platforms (e.g. Marcellus or Haynesville) are experiencing an increasing profit. Nowadays, US mining companies are producing more shale gas than at any time in the past. Five of the six biggest US shale players have increased gas production over the last 7 years. As it can be seen from the Figure 2, the leader of gas production at the US market is Marcellus Shale, which produced 6 million cubic feet of gas per day in April 2014. (EIA: Annual Energy Outlook, 2015)

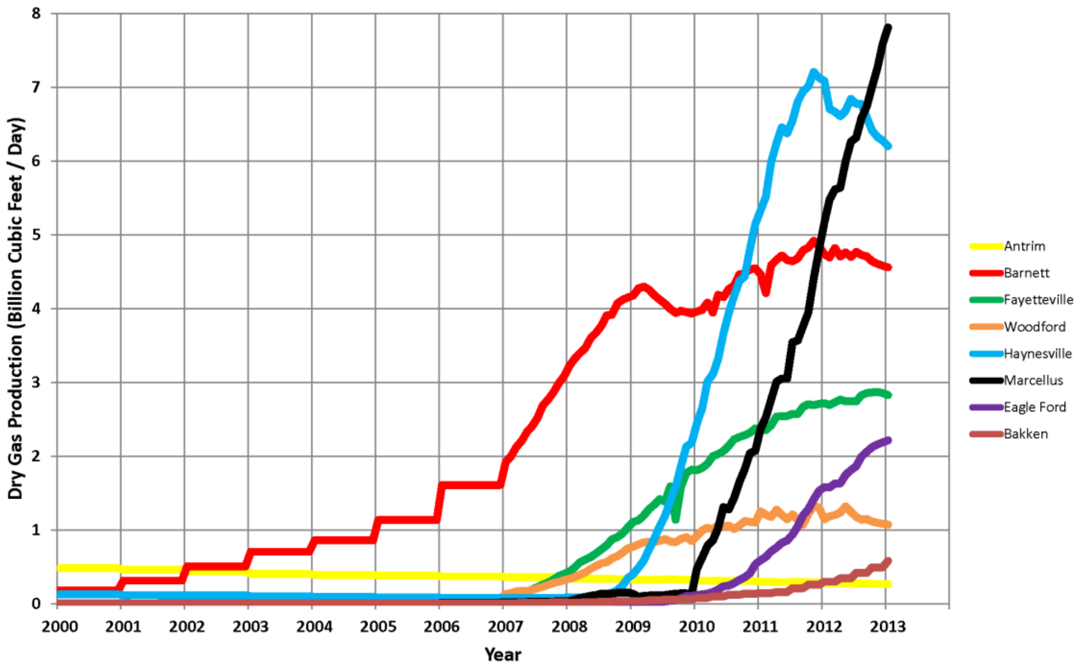

Figure 2. Uncoventional gas production per rig by shale play

Source: EIA,2014

4.2 Price, drilling and forecast

Fluctuation of oil and gas prices at American market is affected mostly by the amount of extracted fuel from unconventional resources. This is why the forecast of drilling and price provided by the EIA is highly valued by analysts and market participants. They are interested not only in the price itself but also in changes of this price since the previous year. The way predicted price is changing over the years helps us to understand the level of optimism of American experts with regard to shale gas and hardly-extractable oil drilling economics.

According to EIA: Annual Energy Outlook (AEO) (2014), the amount of oil extraction rose from 6.5 million barrels per day (324 billion kg per year) in 2012 to 9.6 million barrels per day (478 billion kg per year) in 2014. That is 22% more than AEO 2013 had predicted. Despite of the expected decrease of extracted amount after 2019 (a reason is not stated), the total extracted amount in the US will remain above 7.5 million barrels per day till 2040. The main contribution to these numbers will have the oil extraction. Review of this prognosis is linked to higher recent growth of drilling, where producers prefer to extract expensive oil than cheap gas. Furthermore, oil-drilling companies have learned to identify more reliably the so called “sweet spots” – the most attractive parts of shale plays. The shale oil extraction grew from 2.3 million barrels per day in 2012 (35% of total oil extraction in the US) to 4.8 million barrels per day in 2013 (51% of total extraction), according to AEO 2014. EIA: Annual Energy Outlook (2013) predicted fall of extracted shale oil after 2021, when the drilling should move to less productive areas.

In the last 2014 prognosis (AEO 2014) the possibility of exhaustion is not mentioned at all, but the beginning of decrease in extraction moved from 2021 to 2019. Keeping in mind that the EIA is preparing reports trying to prove the effectiveness of drilling and stating the new technologies allow lesser drilling and extracting more, the contradiction is quite obvious. Growth of effectiveness of drilling (with higher amount of estimated reserves) leads to lower oil extraction in the US. The answer to this puzzle may be simple – with higher amount of wells the amount of estimated reserves should be larger, which has not been observed yet. Therefore, the shale oil and gas extraction should slow down. This prognosis may be corrected in the future.

The EIA predicted accumulated gas extraction to grow from 2012 to 2040 by additional 11% in comparison to previous statistics released in 2013. Again, this is primarily due to the boom of shale gas extraction. In Figure 3 the effect of shale gas drilling since 2007 is visible. The second reason for this growth is the LPG (wet gas) growth and the rising amount of mined crude oil, which is always extracted together with gas. Prognosis of EIA (2014) of accumulated extraction of shale gas is 36% higher than the previous year. Gas prices are higher than the level estimated by the last year prediction due to fast growing demand of the industry. Spot prices for Henry Hub (in relation to AEO 2014 prognosis) will reach 4.80 USD for 1 MBTU (one thousand of British thermal units) in 2018, compared to the price of 4.03 USD for 1 MBTU predicted by EIA Annual Energy Outlook (2013).

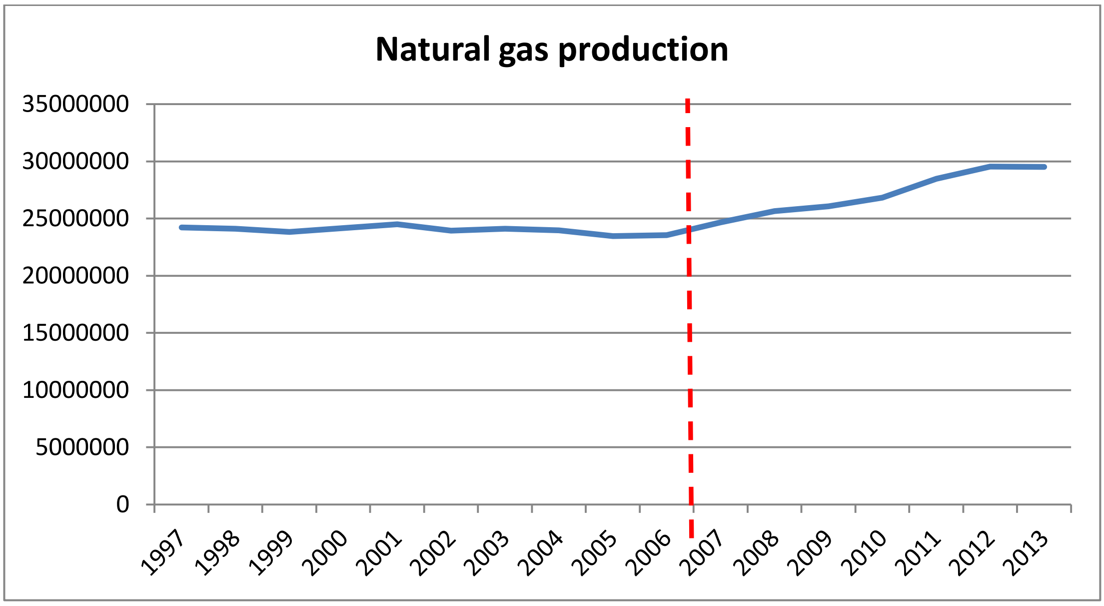

Figure 3. Natural gas production in the US (in million cubic feet)

Source: own figure, based on EIA data.

4.3 Shale gas drilling – direct way to debts and insolvency?

Companies that invested to shale gas and oil mining with conception of fast enrichment are starting to be depressed. Their debts are growing much faster than their incomes. Some investors have already had to provide more capital to ensure the survival of their companies, owing to high investing neediness of horizontal wells, followed by hydraulic fracturing. Companies need an increasing amount of new wells to replace natural decrease of gas and oil.

Total debt of mining companies in the US doubled in last four years and reached USD 163.6 billion, while the income from gas and oil sales increased only by 5.6%, based on the data from the 61 biggest mining companies in the US (EIA: Annual Energy Outlook, 2014) One fifth of these companies spend 10% of their income just to repay debt interest. For example, Texan company Quicksilver Resources admits they spend 45% of income on debt interests. Even though they have stated they have taken measures to lower debts (Quicksilver Resources, 2014), this effort may cause bankruptcy. Companies need to borrow money to excavate more wells in order to preserve stable capacity of mined gas and oil.

Investors have already forced 26 out of 61 companies to cut expenses on wells. However, lower amount of new wells leads to a decrease of mining and therefore decrease of income. Debt burden therefore becomes more sustainable (BP Statistical Review of World Energy, 2015). Miners slowly move from gas mining, which is not able to cover all mining costs, to more cost-effective shale oil. Shale mining of oil has raised domestic US production to 8.4 million barrels per day in 2014, which is the highest level since 1986, and 16% more than in 2013.

Shale plays need more wells that conventional plays and therefore the capital costs have to raise as well. Mining company Goodrich Petroleum tries to push down the one-well-expenses to USD 11.5 million. Despite this, the company had loss of USD 52 million in the first quarter of 2014. (BP Statistical Review of World Energy, 2015) Some of the miners have already tried to solve debts problems by selling of licenses or lands with shale plays. Some of them try to look for help abroad; e.g. Swift Energy has created the joint venture with one of the Indonesian state companies to pay its debts.

Browning et al. (2013) from The University of Texas in Austin provides cost effectiveness study on ten productive desks of Barnett Shale. According to Browning et al. (2013) the wet gas drilling from shale plays is cost-effective with no profitability from 2 USD/MBTU. He also proved that shale gas production is sensitive to market price of oil and LPG. He provided the analysis of few major US drilling companies and concluded that the wet shale gas drilling is profitable only together with shale oil drilling and that the economic situation of the major US drilling companies is stable. The statistics of two companies are provided in Appendix. Browning also noted that the resources at shale plays are exhaustible quicker than conventional resources and therefore companies are forced to drill four times more wells per year than in the in case of using conventional gas wells. He also noted that pipeline connection among states is still missing in the US and therefore the price of natural gas for final consumer varies from 8 to 18 USD per thousand cubic feet. The situation is likely to change after the opening of the Keystone-XL Pipeline project[6].

[6] To find out more about the Keystone-XL Pipeline project please visit the official webpage, the link is provided in the part Bibliography.

5 Energy security of the European Union

The European Union is targeting ambitious plans to combat global warming problem and at the same time is trying to be the economic world leader. The EU was probably facing the problem of energy security more severely than the rest of the world back in 1990s and in the beginning 2000s. However, due to the rapid processes linked to the shale revolution in the US (natural gas price decreasing, transformation of world market, starting discussions of energy security etc.) on the natural gas market in the last decade the gas aspect of energy security of the EU does not appear so troublesome, as it seemed few years ago. This was caused by a new era of the globalization of energy sector, which manifested in two basic tendencies. Firstly, it is the new prospect of unconventional resources of natural gas in the whole world. Secondly, different conditions for realization of the key element of energy security politics – diversification of import supply. The first tendency is linked to the processes at world gas market, which the former CEO of BP Tony Hayward called the "Quiet revolution". (House of Commons, 2011, p.8)

5.1 Dependence on import – raising pressure to solve energy security problem

The European Union annually consumes approximately 450 billion cubic meters of gas while the net production of the EU is only 167 billion cubic meters (Figure 4), only 38% of total consumption. (EIA, 2014) Gas is being imported either by pipelines (specifically from Russia and Norway, with total share of 86%) or in the form of LNG (e.g. from Algeria). The major supplier, Russia, exports 76% of the fuel (oil and gas together) to the EU; therefore the dependence is mutual. The dependence of EU countries is showed in Figure 5.

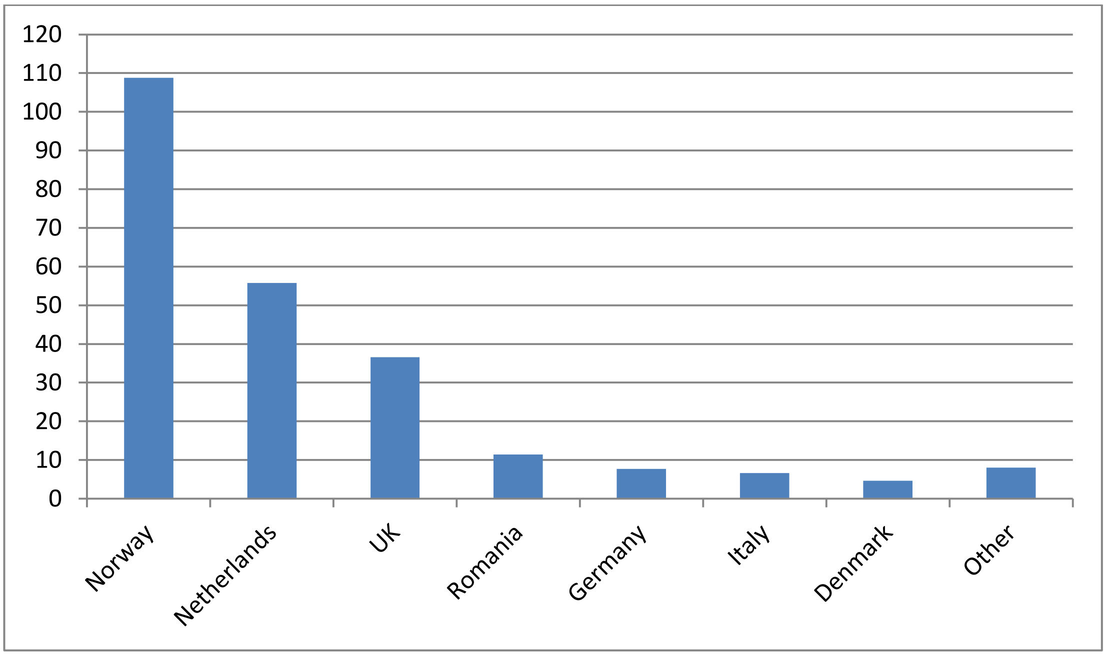

Figure 4. Natural gas production in EU + Norway (in billion of cubic meters), 2014

Source: own figure, based on BP (2015)

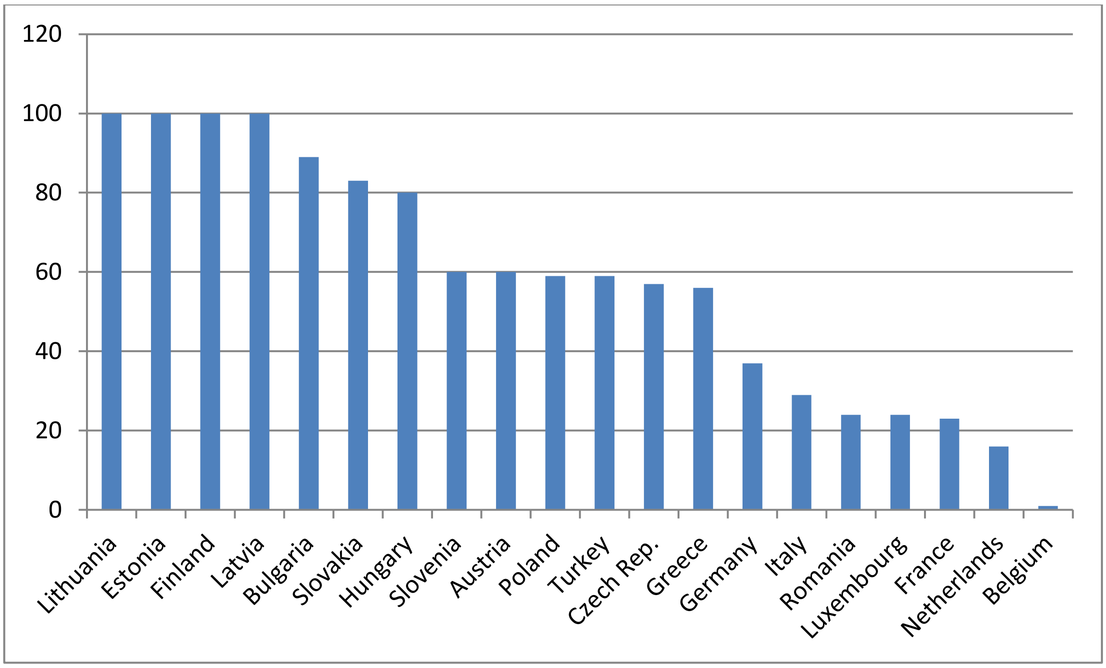

Figure 5. Natural gas import from Russia dependence (% of total consumption), 2012

Source: own figure, based on Eurogas

Russia with the largest natural gas reserves in the world is neighbor of the EU, hence Russia is a logical option for solving the issue of lack of energy resources. Export of natural gas to the EU makes 65% of total export of Russia – the rest is intended for Turkey, Ukraine and Belorussia. This export does require to too much logistical maintance, since all Eastern countries are connected to pipelines built during the Soviet era. As was already mentioned, costs for transport and storage are in case of natural gas higher than costs for oil transport, therefore there is nothing like global natural gas market.

The problem of Russia, as a partner, is instability of supplies. Approximately 40% of Russian gas pipelines crosscut Ukraine and due to unstable Ukrainian economic situation, natural gas (together with oil) is used as a tool for political pressure. The longest gas crisis in 2009 was not the first case of political gas blackmailing. In the early 1990s Russia stopped to supply Baltic countries to reinstate order at the time when Baltic countries tried to become independent. In 1994 Russia had energy network dispute with Ukraine, between 1998 – 2000 Lithuania had to solve energy security due to lower imports from Russia, when Litva was trying to sell pipelines and refining companies to foreign investors. Nevertheless, two crises in 2006 and 2009 were the most serious ones because they affected the whole Europe. In both cases the reason was Ukrainian insolvency.

Despite Russian Gazprom was not to blame, this created doubts about the stability of supplies as a whole and energy security itself. Transit countries could cause serious energy problems in final customer countries due to political situation in Eastern Europe and customers in Western Europe do not have tools for immediate solution of these difficulties. However, the EU has practically two ways how to increase its energetic security. Firstly, the EU member countries should be united at bargaining process. Secondly, the EU constantly wants to increase energetic independency. The shale revolution in the US came in the very right moment as a possible way how to deal with energy security in the EU. In 2009 – at the time when success of shale gas drilling in the US was already proved and after the Ukrainian gas crisis – the European Commission started to consider shale gas as a major tool for becoming energetically independent.

Therefore two possible solutions for the EU energy security problem could be:

1. Own drilling wells, usage of European shale gas reserves
2. Import of shale gas from non-EU countries

5.2 Shale gas – current situation in the EU

As was already mentioned, shale gas miners use special drilling technology – horizontal drilling and subsequent hydraulic fracturing because shale cannot be separated using the conventional drilling technology. Due to higher cost of hydraulic fraction, this method is used to mine classical hydrocarbon extraction (natural gas) only exceptionally. This method was limited to some conventional reserves in the North Sea in Europe, in United Kingdom and some other countries, like Netherlands, Denmark or Germany. These drilling activities did not produce much gas and did not lead to substantial profit. The list of usages of this method in Europe is provided below (Broomfield, 2012).

	2011	**2013**
Total EU	**18.1**	**13.3**
- France	5.1	3.9
- Germany	0.2	0.5
- Netherlands	0.5	0.7
- Norway	2.4	0
- UK	0.6	0.7
- Denmark	0.7	0.9
- Sweden	1.2	0.3
- Poland	5.3	4.2
Total US	**24.4**	**16.1**
Total World	**187.5**	**203.9**

Table 2. Unproved shale gas technically recoverable reserves (in trillion of cubic meters)

Source: Own table, based on EIA (2013)

The most significant resources of shale gas in Europe are in Poland, France and Denmark (Table 2). At the same time, Poland also possesses huge reserves of methane in the coal plays. (Gény, 2010) However, we have to consider that all estimated workable reserves of unconventional gas outside the US are very approximate. The most accurate estimates of reserves is provided by the U.S. Energy Information Administration (EIA) of Department of Energy, which estimates only the reserves of shale gas.

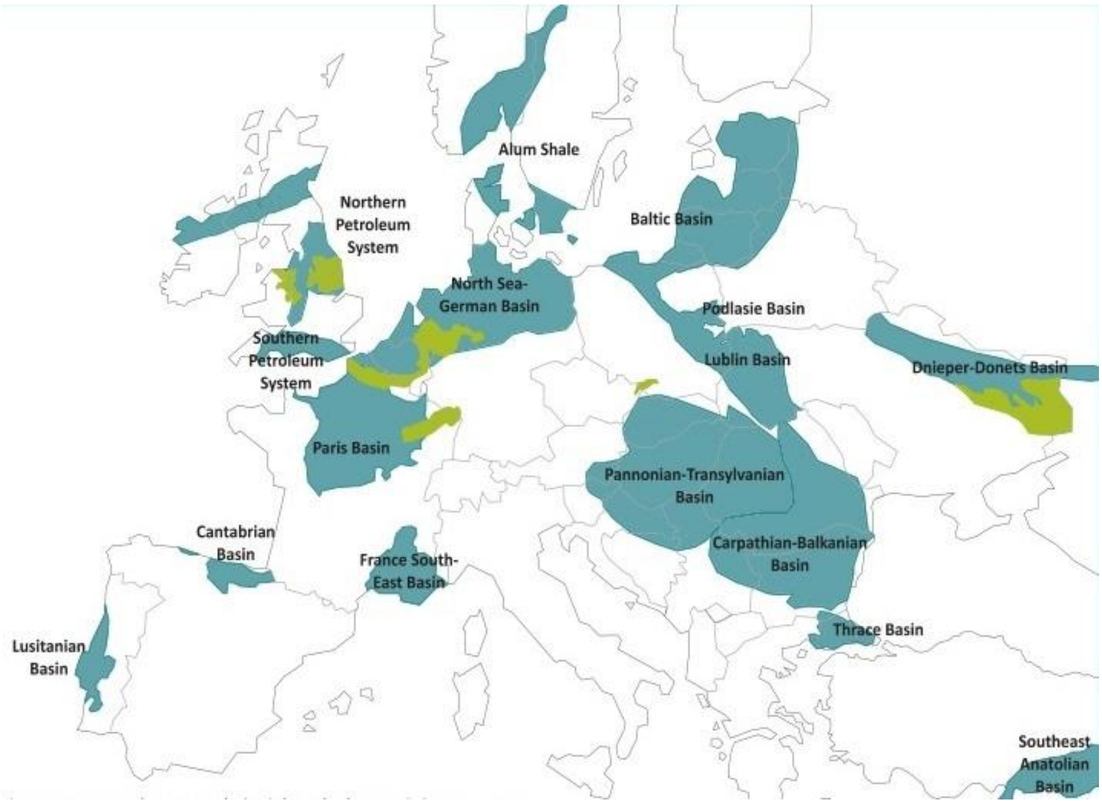

Figure 6. Shale plays in Europe

Source: Aitken (2012)

As we can see on Figure 6, the large reserves of natural gas in unconventional resources are placed in the countries of Eastern Europe, which consume much less of gas in comparison with the Western Europe countries. These countries have greater potential for growing consumption of energy resources and they have more possibilities for its diversification by increasing the share of natural gas in the energetic mix.

5.2.1 Case study: Poland

The most auspicious country in Europe where the shale technologies can be used not only theoretically but also practically is Poland, which historically was always energetically dependent on the Russian Federation and was trying to find alternative way of gas import. In 2009, the 9.15 billion m^3 of shale gas were imported to Poland, whereas 7.15 billion were supplied by Russia and 1.5 billion by Uzbekistan (BP Statistical Review of World Energy, 2015) through Russia, which means that more than 90% of imported gas was controlled by Russia. However, the portion of gas consumption is only 14% of total primary energy consumption in Poland (European Commission, 2014). Natural gas has not acted among the primary energetic sources in Poland, therefore the significance of dependence on Russia is politicized without any economic reasons. (Liuhto, 2010).

Nowadays, Russia imports to Poland approx. 9-10 billion m^3 of gas per year, and due to the contract, signed in the end of 2010, this can be even 10% higher. Under conditions of energetic policy of the EU, which is concerned about the global warming, Poland will have to raise the consumption of natural gas. Up until recently there was no alternative to Russia as a supplier. Nevertheless, the progress of drilling the gas by unconventional methods can markedly change the conditions of energy security of Poland. According to Gény (2010) this is only theoretical project of politicians. The price of such gas would be much higher than the price of Russian gas from pipelines, as well as the price of LNG imported from Middle East and Arctic Sea. (Gény, 2010)

On the other hand, the unconventional gas development viewd from the political side in Poland could be well-founded. Based on the pessimistic estimations (Gény, 2010), the production of gas by unconventional methods could be 4.2 billion m^3 in 2020. If, for example, the majority of this gas will be drilled in Poland, it can lower the demand for gas from Russia by one third. And if we will take optimistic scenario, which predicts between 800 and 1000 wells every year (Gény, 2010) and expects European countries to achieve the level of 28 billion m^3 of natural gas drilled from unconventional resources, this will produce double volume of gas consumed in Poland.

Geological conditions and political willingness are only a part of necessary conditions for successful development of gas drilling by unconventional methods. Appropriate law regulations are significant for success too. Poland is far ahead of other member states – at least in the sense of adaptation of this law. Poland, together with India and China, has become one of the key partners of the US in the Global Shale Gas Initiative (GSGI) program, which was launched by the US government in April 2010. Its goal is co-operation in the exporting of shale revolution to the other countries. This program was a result of co-operation of China and the US in the field of searching for unconventional gas, which was confirmed in November 2008. Within the framework of this program the government of the US declares the support in terms of reserves estimation, technical support of drilling perspectives, estimation of economic potential of reserves and performing seminars linked to technical, ecological, economical, law an tax aspects of gas extraction. Furthermore, the US can administrate support to other countries in dealing with various American companies.

Creation of favorable regime allows Poland, as well as to other countries, to attract the private companies with suitable technologies to develop the gas extraction by unconventional methods. In compliance with these difficulties the suitability of realization of any projects will depend not on economic but mostly on political conditions. That is why we should not expect wide-scale production of gas by unconventional methods in those countries, which have already successfully diversified the import of natural gas – e.g. Spain, France, Great Britain or Netherlands. In Germany the popularity of “green” political parties is growing, but Germany still remains the leader between science centers in the area of studying the unconventional methods of gas drilling. Project GASH was already launched in Potsdam (Gas Shales in Europe)[7], which should analyze the geology of European shale gas plays in detail.

[7] For more information about project GASH please visit official GASH website. The link is provided in Bibliography.

The Polish example demonstrates tendency, which can completely change the understanding of the term “energy security” – firstly, among the Eastern countries, and after that in the rest of Europe. The primary source of these changes will be the “silent” shale gas revolution in the US; countries of the Eastern Europe could feel consequences directly and the rest of Europe indirectly. One way or another, these changes seem to be the serious challenge for Russian gas companies and for large-scale Russian projects. Whereas not only as a competitor but also as a contributor to formation of unique energy market of the European Union and creation of united energy policy.

Poland had the biggest ambitions in shale gas drilling among the EU countries in November 2014, with 67 exploration wells done at that moment. (BP Statistical Review of World Energy, 2015) It was not much but an increase was expected. However, in January 2015, the drilling concern Chevron followed ExxonMobil, Total and Marathon Oil companies that ended research of shale gas plays in Poland. Decrease of world oil prices forced these companies to lower the expenses and cancel low-profit bringing investment projects. Even though the shale gas reserves created lots of promising space to change the energetic structure in the Eastern Europe, depending on Russian import; the reality was not able to meet the expectations. Despite the corporations were expecting largely profitable and economically effective gas plays, after they have started to drill exploration wells, the initial estimations were lowered, geological conditions appeared to be very complicated and government regulations inflexible. Another major mining company, British Cuadrilla Resources opened its first office in Poland in 2009. It was convinced that the biggest country in the middle Europe will turn into “European Texas“ for miners, thanks to large reserves of shale gas. Still, after six years of preparation Poland has not started do drill even experimental wells. These are very low indeces for a country, which has the biggest enthusiasm for own shale gas drilling among countries in the EU. The costs of the exploration wells have appeared to be much higher than in the US and legislative regulation was also proven to be tougher than in the US.

After all, Poland has still not lost all hope for unconventional gas resources. The biggest Polish refinery group PKN Orlen will continue in exploring of shale gas plays in Poland, despite most of other companies has already ceased from drilling due to bureaucracy and difficult geological conditions. The general director of company Jacek Krawiec has announced that the technology will evolve in near future in favor of economically-effective drilling. (PKN Orlen Press Release, 2015). According to Polish National Geological Institute[8] there are large resources of the so-called tight gas in the north and in the central part of the country. Tight gas is drilled from sandstone in the US for almost 30 years. Except for the US it is also being drilled (obviously in much lower amount) in Germany, Netherlands, Russia and Argentina.

5.2.2 The EU countries – high level of enthusiasm with uncertain future

Since the shale gas plays are not presumed to be located in all EU member states, only short review of the situation in main EU candidates for commercial shale gas drilling is provided, besides Poland. Broomfield (2012) provided structural overview of estimated reserves in Europe, according to data from 2011. This overview can be found in Appendix.

Hungary

In November 2014, Hungarian representatives announced they would like to start shale gas drilling, irrespective of all ecological worries. According to Attila Nyikos, the Vice-president for international relations of the Hungarian Regulatory Office (ERU, 2014) the country would like to be more independent on Russia (currently 80% of all consumed gas is imported from Russia) and become one of the EU countries, which are going to use unconventional gas plays. Hungary has already done hundreds of exploration wells on shale gas plays and one of these wells is being already used by Canadian company Falcon TXM. According to exploration wells there are around 1500 bn m^3 of shale gas in low-permeable plays, which would cover the current demand for gas in Hungary for 120 years. (BP Statistical Review of World Energy, 2015)

[8] For more information please see the official website of National Research Institute of Polish Geological Institute. The link is provided in Bibliography.

United Kingdom

According to the report by Green (2012) for UK Department of Energy and Climate Change, only one well (in Preese Hall, Lancashire) is used for shale gas drilling in Great Britain. Available data for this specific well show high volume of shale gas reserves. British reserves of shale gas are probably greater than initially expected. According to provided estimation there are more than 4810 cubic kilometers of natural gas on the surveyed land in the northern part of Great Britain. This is twenty times more than was claimed before. Andrew Austin, director of IGas (one of the companies, which were permitted to research and mine) has stated that this estimation shows that this amount of gas is sufficient for 10 to 15 years without need of import of any kind. (Green, 2012) However, IGas still does not know how much of this gas is economically-effective to drill.

The French oil syndicate Total has announced in 2014 (Total Annual Report, 2015) its ambition to drill shale gas in Great Britain. It plans to invest more than EUR 36 million in exploration wells in this country, as the first supranational oil company. French giant can intensify the effort of British government to enlarge the area of possible shale plays exploration and gas drilling. Total should receive around 40% share at Lincolnshire in middle-east England from local companies Dart Energy, Egdon Resources, IGas and eCORP (BP Statistical Review of World Energy, 2015), which have already got licenses for exploration wells but have not started yet. Current (2015) British government with David Cameron as prime minister supports the unconventional technique of gas drilling.

Romania

Romania is the excellent example of so the called “shale illusion”. In 2011, at the time when no exploration were done, the EIA made estimation of 51 bn m^3 of shale gas reserves in Romania, which should cover Romanian gas consumption for approximately 100 years (EIA: Annual Energy Outlook, 2011). The US Chevron mining company was attracted by EIA estimation and the exploration works started to be prepared in 2012. However, in the end of 2014 company Chevron announced (EIA: Annual Energy Outlook, 2015) that shale gas production in Romania has no future potential. Specifically, the internal Chevron analysis has shown that project of shale gas production in the Black Sea region cannot be economically profitable as another project, in which Chevron invested; and company has officially refused to continue in production due to uncompetitiveness. No other investments in shale gas drilling in Romania are planned at this time (September 2015).

Czech Republic

The natural gas consumption in the Czech Republic is approx. 8.7 bn m^3 per year, whereas 2% of gas is originally Czech and 98% is imported. The Czech Republic imported about 78% of its consumption from Russia and about 20% from Norway in 2013 according to Czech Statistical Office (ČSÚ) statistics.

Four companies in total has sent official requests for shale gas research in the Czech Republic – BasGas Energia Czech, Cuadrilla Morava, Hutton Energy and Cuadrilla Resource Holdings, all of them in 2011 and 2012. (Osička, 2013) Five regions were chosen for exploration wells – areas of Karlštejn, Trutnov, Hodonín, Zlín and Nový Jičín.

Local representatives in cities and regions around the territories intended for research are against drilling; dozens of non-government organizations and civil associations actively promote the same opinion. The civil association "STOP HF" was established in 2012 to warn public against hydraulic fracturing because of high risks of ground water pollution and a petition[9] for national prohibition of this technique was signed by more than 36 thousand inhabitants. (Osička, 2013) Due to the lack of public support and significantly negative perception, Czech government amended legislation for shale gas drilling using hydraulic fracture. Based on the environmental issues hydraulic fracture is not prohibited but legal formal barriers apply, making the ability of drilling for private companies almost impossible[10]. Some requests were rejected by authorities; the rest of them gave up due to high bureaucracy and strict state regulation. The last company, Cuadrilla Morava, ceased its operations in February 2015.

Hydraulic fracturing method with vertical wells was used in **Germany** already in 1980 at the Soehlingen field but only for experimental purposes. In 1999 and 2000 several horizontal wells with hydraulic fracturing were realized. None of

[9] Link for petition is provided in Bibliography.
[10] Law of the Czech Republic: zákony 44/1988 Sb., 61/1988 Sb., 62/1988 Sb., 100/2001 Sb.

the wells was economically successful. Due to environmental risks, German representatives do not plan to realize any more exploration wells in Germany today (Broomfield, 2012). More promising situation is in **Denmark**, where 130 exploration wells using hydraulic fracturing have been installed in North Sea since 2000, with 10 to 20 fracture stages each but due to the limits of reserves no commercial drilling is being considered (Broomfield, 2012). Method of hydraulic fracturing was used in **Netherlands** for the first time in Europe already in 1950s and after that approximately 200 wells in the depths between 1600 – 4000 meters were drilled (Nogepa, 2012). Nowadays there is a similar situation as in Denmark.

5.3 Possible importers of shale gas

5.3.1 Import from the US

Despite huge reserves of gas in the US it is too far away from being exported to Europe. This is mitigated to some degree by difficult geopolitical situation in Europe and Russian threats. One can ask if this could be crucial moment for energy security of the EU.

US President Barack Obama, despite the resentment of American industry, promises to release tariff barriers and flood Europe by shale gas. In March 2014, during the press-conference summing up the US – EU summit in Brussels president Obama declared that the US have the possibility to share their resources with the European market. According to Obama, the US have moved forward sufficiently in elaboration of new technologies and US government is ready to release new licensees for export. So far export of American gas is intended for open market and not for specific consumers. (The White House, 2014a) In the official summit statement it is stated that "*We welcome the prospect of U.S. LNG exports in the future since additional global supplies will benefit Europe and other strategic partners*." (The White House, 2014b)

According to CEDIGAZ (2014) data, countries of the EU imported 64 billion m^3 of LNG in 2012 and this number decreased to 47 billion m^3 in 2013, in comparison to 161.5 billion m^3 of gas imported from the Russian Federation. In Spring 2014, the US Department of Energy (DOE) certified seven projects for LNG export, in total of 96 billion m^3 per year. At the same time, the Federal Energy Regulatory Commission (FERC) agreed to launch only one project – Sabine Pass, presented by the company called Cheniere. This was the only project for export of 22.7 billion m^3 per year, which was confirmed by the DOE. All other projects are still not confirmed; even though they received required certification. That is why the declaration of Obama should rather be understood as moral support for the EU efforts to diversify the sources of energy imports.

On the other hand, Obama's optimism is based on official prognosis of the EIA, which predicts the US will become net exporter of natural gas before 2018 (EIA Annual Energy Outlook, 2014). According to this prognosis the amount of exported LNG will reach 56.6 billion m^3 per year in 2020 and 99 billion m^3 per year in 2029. Nevertheless, this amount would cover not even a half of European gas demand and at this time it is destined for ATP gas and oil company market. Conjuncture of local markets will be crucial for further development. Many factors can affect this conjuncture – not only the demand for gas or import of LNG from other parts of the world, as it is discussed later on, e.g. Middle East, Africa, China or Australia, but also extension of Panamanian canal (and building Nicaraguan canal), economic and political conditions in producing countries etc. In any case the export of American gas to the EU will be possible no sooner than before president Obama's term of office will expire.

Legalization of gas export from the US

Based on Natural Gas Act (NGA) from 1938[11] US federal government regulates the export and import of natural gas. The main aim of this law is to protect public interest. On 29th May 2014 the DOE announced changes in the system of issuing certifications for LNG export. The procedure of certification for 48 countries, which are not members of the Free Trade Agreements (FTA) has already started. In relation to the EU the analysis of both macro- and microeconomic consequences has to be done, as well as legalization of whole trade.

The first step would be to have FTA between the EU and the US, which is currently being negotiated between the two continents. Czech diplomats advocate for simplification of export and appropriate changes in American law. Once the FTA is in place, the process of granting permission to export gas to Europe will be much

[11] Link for NGA is provided in Bibliography.

easier. Instead of several years, acquiring a license to export will take only few months.

Meanwhile, many experts are skeptical and hold back premature euphoria. Establish gas import from the US is not a matter of a few months. Realistically, we cannot expect that it would be possible for the US to export gas sooner than in four or five years. G7 countries support the steps that lead to the use of shale gas in the US and Canada for future replacement of supplies from Russia. This was stated at G7 meeting in May 2014. The strategic decision has been taken recently and began to take action due to the fact that Russia uses energy as a blackmail instrument.

The legislative process is so complicated and costs for transportation are so high, that the most realistic estimation is that drilling companies in the US are planning to export gas to the end of the decade, around year 2020. The import of shale gas from the US seems to benot possible up to September 2015, as it is restrained by laws and weak infrastructure. Ukrainian crisis and willingness of the European Union to become independent on Russia have increased the chance that the gas fields of North America could in future supply domestic households in Europe.

Terminals & pipelines

The only way how to get gas from US drilling wells to the European pipelines is to liquefy it and transport by boat across the Atlantic to European port terminals where it is again converted to gas. It is expected that the cost of transportation will more than double the price of gas, not mentioning the costs of building a necessary infrastructure. Although there is already 20 (KPMG, 2014) port terminals in Europe most of them are located in the west and south of Europe, as we can see on Figure 7. For the Czech Republic the important terminal lies in Świnoujńcie in Poland. This terminal should be completed after five years of construction in 2016 and according to the national energy policy liquefied gas could be directed through the planned pipeline Stork II terminal directly to the Czech Republic. In the first phase, however, Poland expects gas supplies from Qatar. Shale gas from the US might be imported only after the opening of the US market.

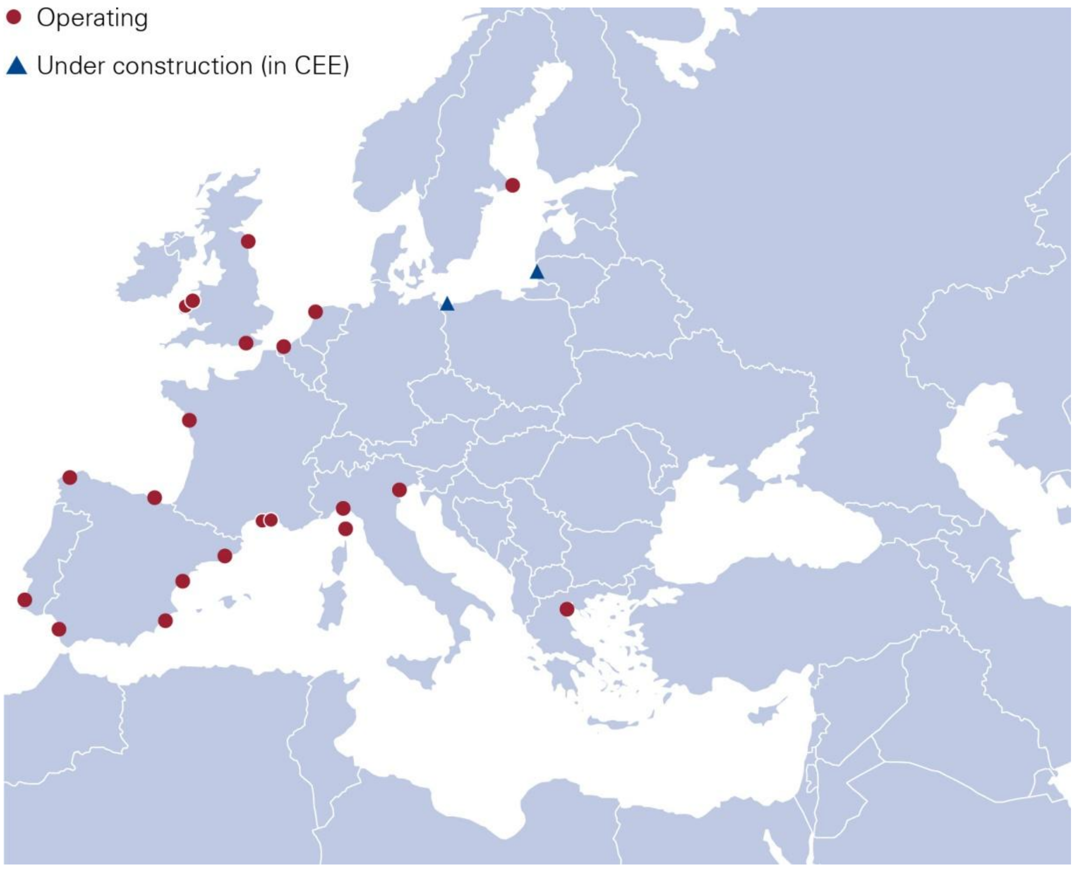

Figure 7. LNG terminals in Europe (February 2014)

Source: KPMG

5.3.2 Algeria

According to the 2013 annual report by the U.S. Energy Information Administration (EIA: Country Analysis Brief: Algeria, 2014), Algeria disposes of one of the biggest shale gas reserves in the world. The total reserves of technically recoverable shale gas are estimated to over 20 trillion cubic meters of gas. Only two countries – Republic of China and Argentina – are expected to have more shale gas than this African country. The reason, it is necessary to focus on Algeria is the location of the country. It is situated much closer to Europe than other countries from list of the top shale gas holders. Algeria is one of the main importers of natural gas to southern Europe, especially to Italy, so that basic infrastructure for transport and LNG (Liquefied Natural Gas) stations are already present. Therefore, the transportation costs are going to be much lower than in other cases.

According to the EIA statistics (EIA: Country Analysis Brief: Algeria, 2014) Algerian oil reserves and natural gas reserves are not that extensive as it was expected and the actual production of these two crucial fossil fuels is declining over past several years. In 2005, according to state energy company Sonatrach (Sonatrach Annual Report, 2010), Algerian drilling companies drilled out 65 billion cubic meters of gas. Since then the production was constantly declining to 45 billion cubic meters in 2013. Algeria has to consider other unconventional methods of energy drilling. Algeria officially announced in May 2014 it will start with the exploitation of the country's shale gas reserves in near future (possibly in 2016. Algerian government has started to look for foreign investors in order to exploit its fields. If the expectations of the EIA are based on true values and the reserves will be commercially exploitable, Algerian officials claim that 11 shale gas wells will be drilled around 2020 – 2025. (EIA: Country Analysis Brief: Algeria, 2014)

Since the exploration wells confirming the presence of large shale gas reserves in Algeria were not drilled yet, status remains to be uncertain. And even in case of confirmation the first liquefied shale gas can be expected to be imported not sooner than in 10 years from now.

5.3.3 Iran

Iran tries to take advantage of unstable political situation in Europe and proposes its own solution to the European Union. Iran announced recently (April 2014) that it is willing to supply natural gas to Europe in case of Russian supply interruption. (Critchlow, 2014) Similarly to other countries of Persian Gulf Iran is able to supply gas in large volumes to other countries; in fact, Iran is owner of the second largest natural gas field in the world. However, too many questions remain to be unanswered.

The first one is sanctions of the European Union against Iran because of its nuclear program. Nevertheless, US have already broken this energy sanctions, and in 2013 Iran contracted a deal with the UN to limit the nuclear program. If Tehran will be willing to rebuild business contracts with Europe, it will have to accept European conditions..

Secondly, Iranians are in need of financial support as they plan to invest around USD 14 billion to develop both oil and gas shared-fields with its neighbors in the Persian Gulf. (Critchlow, 2014) Discovered in late 1980s, development of drilling wells in the Persian Gulf area has been accompanied by several problems, including contractual disputes or the already mentioned sanctions that forced big international oil and gas companies to step back. Some European oil companies, such as Norwegian Statoil, invested money to development of gas fields in the Persian Gulf, years before sanctions were applied and they are willing to reconsider cooperation with Iranians and support more investments in the area. With additional investments from various stakeholders this area could become the largest exporter of LNG in the world and a global energy superpower.

Finally, there are significant issues with transportation. Up to date, there is no pipeline, which connects Europe with the Persian Gulf. The project "Nabucco"[12], which planned to build pipeline from Iran to Azerbaijan failed to be realized in 2013. The second possibility is gas in the form of LNG, which would be transported to LNG terminals (directly to the European market) but they would have to be built with high costs and shipping would be too long and too costly. The question of economically effective transportation remains to be solved.

[12] **Nabucco-west pipeline project** was proposed gas line connecting Azerbaijan and Iran with the European Union, via Georgia and Turkey to Bulgary and Romania. Preparations for this project started in 2002 and intergovernmental agreement was signed in 2009. However due to political and legislative reasons the project was stopped in 2013 and Nabucco consortium was sold to Shah Deniz, subsidiary company of BP.

6 Short essay on the convergence of the US standards and the standards of the European Union

The development of shale gas industry in the US has inspired the biggest economies in the world. Besides countries like China, Argentina or South Africa, the US model is being considered to be applied also in the EU. Several major energy companies and government representatives promote improvement of the US model and its application in Europe to minimize the natural gas import dependence. Multinational mining companies, which missed the initial growing phases of shale gas production in the US, aspire to get the official permissions for exploration wells and acquire lands in the EU for promising prices and sufficient reserves expectations.

After natural gas import crises in 2000s, the European Council expressed emphasis on targeting maximal self-sufficiency and improvement of energy security, to change the natural gas market in the EU in short-term (in the same way, as it happened in the US), and to decrease natural gas price (Figure 8). In February 2011, the European Council stated in a cover note that "*in order to further enhance its security of supply, Europe's potential for sustainable extraction and use of conventional and unconventional (shale gas and oil shale) fossil fuel resources should be assessed*." (European Council, 2011)

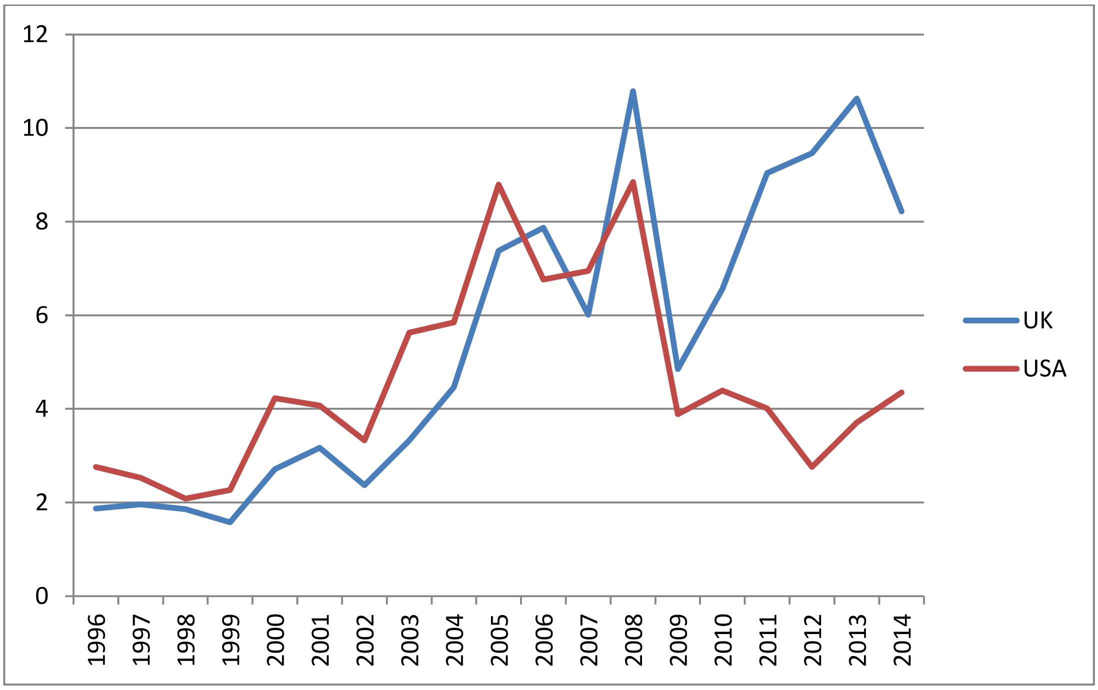

Figure 8. Residential price of natural gas – comparison of UK and US, in US dollars per MBTU

Source: own figure, based on BP data (2015)

6.1 Comparison review

As mentioned before, the European gas market is highly different from the US market and adaptation of American model to the EU would be problematic due to the following reasons.

In general, the differences in market structure are crucial. The US is historically the biggest oil and gas producer in the world, which makes it highly favored. While in the US the energy industry including shale gas (or natural gas) drilling is one of the fundaments of the US economy, there is no similar historical precedent in the EU. US miners have decades of experience, developed infrastructure and millions of people employed, directly or indirectly. The US regulation is therefore strong and binding for market participants, opposed to the situation in the EU, where no common rules have been applied yet. It is crucial that the shale gas production experience and special technology knowledge are needed and in the US there is a network of companies providing services and utilities for gas drilling. There is a limited number of US companies with these skills in the US and the EU market is not the most attractive option for them in a global context; instead, these concerns are self-assertive in Argentina, Canada and China. (Kuhn and Umbach, 2011) The institutional background and needs of society have to be kept in mind. European countries with complex barriers for drilling (which are discussed in the thesis) are not able to compete with countries with large reserves, providing more suitable conditions for drilling – both political and economic. For the business strategy the EU is considered as a possible consumer by the US companies. Europe is much more environmentally cautious as there are massive protests of ecological associations keeping close track of environmental hazards. Intergovernmental regulations (environmental standards on the EU level) and also legislation and prohibitions on governmental[13] level need to be considered too.

Due to a high number of wells drilled on the US territory the US mining companies have extensive datasets for geological composition, particularly statistics for shale reserves. The exploration wells are not needed and the initial costs are lower than in any other country. It has turned out the shale (proved) reserves are satisfactory enough to become substitute for conventional methods, at least till 2040 (EIA 2014). The EIA (2012, 2013, 2014) makes the estimation of reserves in the EU every year, however exploration wells were done only in few EU countries (mostly Great Britain, Germany, Poland and the Netherlands). The drilling requirements are associated with higher fixed costs and in most of the EU countries there were not done at all. Therefore these estimations are rather imprecise. In some[14] cases the initial estimations were optimistic but after exploration wells were done, reserves proved to be lower than estimated. In general, the location of shale plays in the EU is more adverse that in the US, the depths of deposits range between 1500 to 4000 m.

Due to long-term contracts with Norway and Russia there is only a limited domestic production of natural gas in the EU. Other factors also need to be considered, for example different geological structure or density of population – in comparison to the US the EU is more densely populated area. The shale production requires a lot of space – infrastructure to be built, water pool and engineering background. Companies in the US have easy access to wells thanks to larger unoccupied territories. While the spacing between conventional wells can be few

[13] Hydraulic fracturing was prohibited e.g. in France, Bulgaria, Denmark, or the Czech Republic.
[14] For details please see cases of Poland and Romania in Chapter 5.

kilometers, the spacing for shale wells has to be hundreds of meters apart from each other at most.

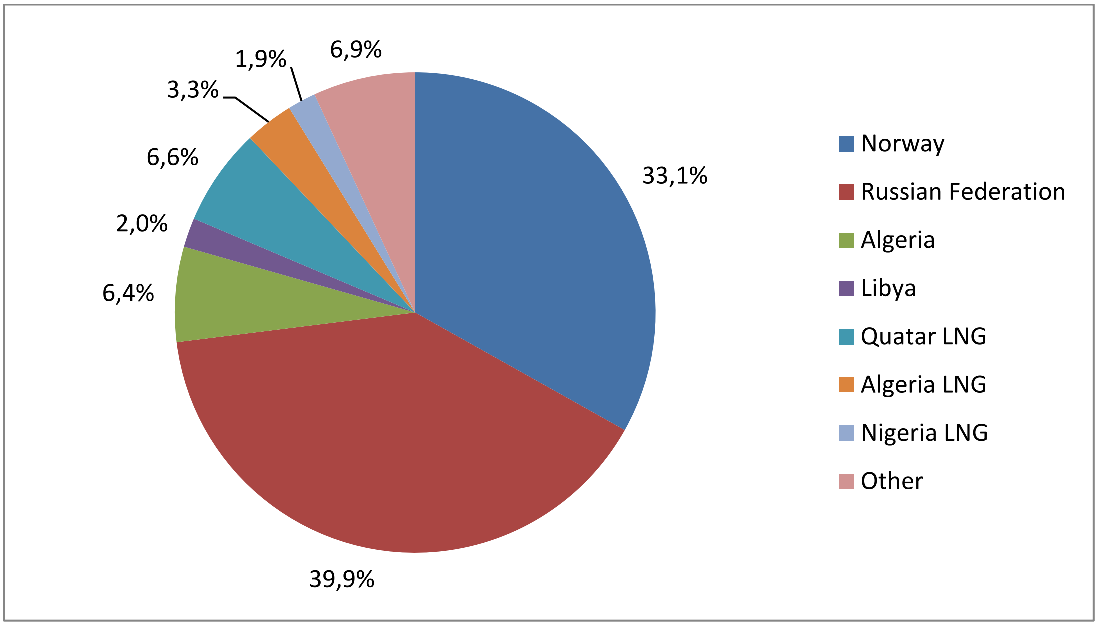

Figure 9. Natural gas import to EU by country of origin (2014)

Source. own figure, based on BP (2015)

Last but not least, the property rights laws are different in the EU from those in the US. Land owners in the US own not only the land but also everything underground; therefore if the mining company buys the land it automatically gets permission to drill minerals or other resources and also a permission to sell it. In the EU property rights for resources located underground belong to a country, therefore it is more complicated for companies (coming from the US) to drill shale gas. This is linked to higher production costs that translate to higher cost of wells. Together with unwelcoming public opinion of the EU citizens the environment for shale gas development in the EU is challenging.

7 Methodology and data description

7.1 Introduction

Due to the recency of topic, no usable data for the EU are available yet. As was described in the Chapters 5 and 6, only estimations of nonproved reserves (published annually by EIA) exist so far, since the exploration wells were done only in few EU countries and in limited degree. The first actual datasets for proved reserves exist only for the Netherlands and the United Kingdom (EIA, 2015), but only for some shale plays. Since the shale gas has not been started to be sold at the EU market yet, we are not able to build a model of the EU. Instead, we will take advantage of available EIA datasets for the US natural gas market to analyze the determinants of natural gas price at the US market and role of shale production in price development.

7.2 Data description

The main source for data for study of US market is Energy Information Administration (EIA), which is the largest US energy agency with wide range of available data for particular US states and a whole country. All datasets – progression of natural gas consumption, residual price of natural gas for consumers, and also production of both natural and shale gas in the USA were downloaded from official website of EIA in September 2015. Most of datasets (for all 50 US states + District of Columbia) needed were available from 1997 to 2014. However, for one of variables – proved reserves of natural gas, dataset was not available for 2014. Therefore the panel data for 51 states and 17 years (1997 – 2013) are used, which provides 867 observations in total.

Therefore for dependant variable of model the residential price was chosen – *average annual residential price* (final price delivered to consumer) in dollars per thousand cubic feet in given US state. Datasets for four (out of five) explanatory variables for main US empirical model were retrieved also from EIA website. The *national gas gross withdrawals* per year are measured in million cubic feet. This dataset provides information about whole production of all natural gas drilled on the territory of the Unites States, by both conventional and unconventional methods. The *total consumption* is provided again in million cubic feet and this shows the total final consumption of natural gas both by final residents (can be both – households and companies). Dataset *reserves* provides data of all US states for wet natural gas after separation proved reserves – all gas reserves, which were proved to exist, measured in billion cubic feet. Several datasets for this variable were being considered to use. Apart from used dataset, statistics for dry natural gas, wet nonassociated and wet associated gas were available. Wet gas after separation was chosen due to better access to datasets.

Shale gas was drilled in the US for decades, but basically only exploration wells were being mined, and no commercial trade was shale gas used for. In 2006 the shale gas has started to be drilled for commercial use, and supporting pipelines were built. In early 2007 turning point was reached and shale gas started to be supplied to final consumers, as supplement of conventional natural gas. Therefore the EIA started to publish data for *shale gas production* in 2007. There are no available data for shale gas mining for years before 2007, but since the shale gas had been drilled in extremely low amounts, and almost not used for commercial trade at all, we simplify our model and we assume no shale gas was drilled before 2007. Therefore the dummy variable is used in the model as index of shale gas production, with 0-value for years 1997 – 2006 and 1-value for years 2007 – 2013. Since 2007 we have available data for all US states, as total gross natural gas withdrawals from shale gas wells per year, measured in million cubic feet.

Dataset for the last variable, *gross domestic product*, was retrieved from Bureau of Economic Analysis (BEA) website in January 2015. Specifically GDP in current US dollars were used in this case, measured in million US dollars, for all US states including District of Columbia, for necessary period 1997 – 2013.

All above mentioned data were retrieved for 51 states for 17 years.

7.3 Methodology

The empirical model is built to estimate determinants of price of natural gas in USA. In this model is provided estimation of relationship between development of price and various factors – gross domestic product (GDP), production and consumption of natural gas, proved reserves of shale gas and dummy variable for shale gas drilling. For the first three variables is considered positive sign. The fourth variable is expected to be linked negatively to price, because it is assumed higher reserves will lead to increase of supply and decrease of market price of gas. Dummy variable shale gas indicated whether shale gas was mined and should be correlated negatively with price of gas.

Based on data analysis the most several econometric models (the most appropriate econometric methods are used with respect to the data – panel data regression with fixed effects (FE) for particular states in USA is constructed and applied. The results enable us to analyze the global market situation and predict the behavior of global gas price in near future.

8 Empirical model

8.1 Description of model

The main model is constructed to estimate the dependence of final consumers' price on gross domestic product, production, consumption and reserves.

Panel data with time series are applied.

The shale gas model is constructed in the following way:

$$price_{it} = \beta_0 + \beta_1 gdp_{it} + \beta_2 prdctn_{it} + \beta_3 cnsmptn_{it} + \beta_4 reserves_{it} + \beta_5 shale_{it} + \beta_6 SG\_prdctn_{it} + \varepsilon_{it}$$

where $i = 1, \dots, 51$ and $t = 1, \dots, 17$ and dependent variable $price_{it}$ is residential price, i.e. final price for consumers (without taxes) in US dollars. Explanatory variables are following: gdp_{it} is GDP of states in current US dollars, in million US dollars, $prdctn_{it}$ is total natural gas production in million cubic feet, $cnsmptn_{it}$ is total consumption of natural gas in million cubic feet, $reserves_{it}$ are proved reserves of natural gas in wet form after separation in billion cubic feet, $shale_{it}$ is dummy variable, when "1" means drilling of shale gas in the state in given year was realized and "0" stands for opposite, SG_prdctn_{it} states for total shale gas production in million cubic feet, and ε_{it} is error term.

The expected signs for the model are presumed as:

Variable	GDP	Natural gas production	Natural gas consumption	Proved reserves	Shale gas production
Expected sign	+	-	+	-	-

Table 3. Expected signs for model

Source: own table

For variable *reserves* the limitation of data is set. Since the shale plays are not presented in all US states, the shale gas is drilled only in 23 US states. Therefore for this variable we have got missing observations for 28 states, due to no data for reserves of natural gas in these states. Instead of 867 observations we use only 391 observations in our model (17 years, 23 groups).

	Estimate	Standard errors	t-value	p-value
gdp	5.49e-06	9.90e-07	5.54	0.000
prdctn	-4.04e-07	5.69e-07	-0.71	0.478
cnsmptn	-1.71e-06	6.56e-07	-2.61	0.009
reserves	.0000662	.0000425	1.56	0.120
shale	2.191658	.2456595	8.92	0.000
SG_prdctn	-1.64e-06	4.87e-07	-3.37	0.001
_cons	8.52433	.6051702	14.09	0.000
R^2-within	0.3379			
Number of observations	391			

Table 4. Outcome of estimation for determinants of price

Source: own results

As we can see, variables *production of natural gas* and *reserves* are verz insignificant for production of natural gas at 48% and for reserves at 12%. Variable *GDP* gas strong significance with positive sign, as was expected. *Consumption* is also significant, but with negative sign. This could be explained as consequence of growing production. Most importantly, variable *shale production* is significant, with negative sign, as was expected. After shale gas had started to be drilled, residential price started to fall decrease. To illustrate this fact, we draw following figure:

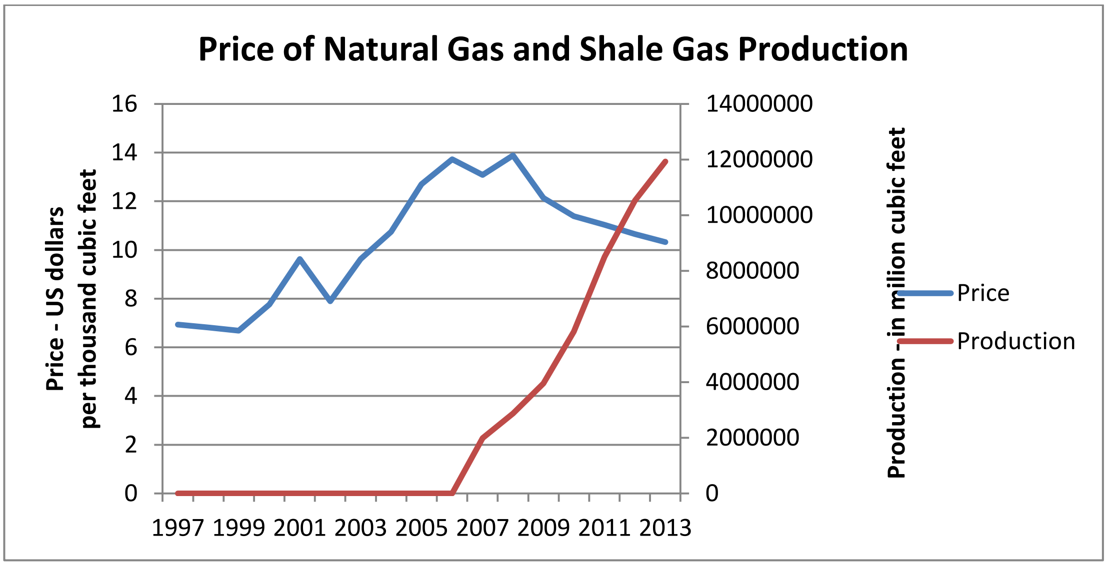

Figure 10. Price of Natural Gas and Shale Gas Production

Source: own figure, based on EIA data

Hausman test is applied to regression .Endogeneity problem arises in this model; therefore the instrumental variables (IV) should be applied[15]. IV used for this model could be the same variables, but for the different territory. (e.g. Argentina). Therefore to deal with the endogenity problem, the data for the other country will be collected and the current model will be adjusted with IV used.

Simultaneously, the Hausman test showed that Fixed Effects are more expected to provide more accurate estimation of coefficients.

8.2 Estimation using Fixed Effects (FE), by within transformation

The model is transformed to error-components model where the error term is split into country-specific and idiosyncratic error, by following way:

[15] Author's note. Introduced model was designed by initial supervisor of this thesis, Mr. Wadim Strielkowski and results were approved by him. However, few weeks before thesis submission,the supervisor of this thesis was changed, and author has noted after consultation with new supervisor, Mr. Karel Janda, the raising problem of endogeneity in this model. Due to the close deadline, this sort of corrections were impossible to be done in reasonebly acceptable form and therefore author has decided to finalize the thesis in current form with note of endogeneity problem. For the defense of this thesis the author will prepare the errata with adjusted model with instrumental variables, as a solution of endogeneity problem in this model.

$$price_{it} = \beta_0 + \beta_1 gdp_{it} + \beta_2 prdctn_{it} + \beta_3 cnsmptn_{it} + \beta_4 reserves_{it} + \beta_5 shale_{it} + \beta_6 SG\_prdctn_{it} + v_{it} + \varepsilon_{it}$$

where v_i are omitted group-specific effects.

We have again missing variables for 28 states due to reasons provided before, and instead of 867 observations we use 391 observations in our model (17 years, 23 groups).

	Estimate	Standard errors (Robust)	t-value	p-value
gdp	6.63e-06	3.37e-06	1.97	0.000
prdctn	1.41e-07	1.03e-06	0.14	0.884
cnsmptn	-2.09e-06	1.84e-06	-1.14	0.048
reserves	.0000481	.0000573	0.84	0.348
shale	2.137295	.3229415	6.62	0.000
SG_prdctn	-1.99e-06	5.38e-07	-3.69	0.001
_cons	8.14119	1.827168	4.46	0.000
R^2-within	0.3398			
Number of observations	391			

Table 5. Outcome of estimation for determinants of price, using Fixed Effects

Source: own results

F-test was applied to regression and confirmed that model is statistically significant. Within R-squared is 0.3398, which means that used independent variables explain about 34% of the natural gas price. We believe, that price is determined by many factors, possibly also by unemployment rate, variety of political parties, EU natural gas price, the development of LNG terminals etc. However the 34% is more than was expected. The estimated coefficients for variables *GDP*, *consumption* and *shale gas production* are significant on 5%. Positive sign of strongly significant GDP variable was already explained before, as well as consumption estimation.

The significance of variable *shale gas production* was proved. The year 2007 was the turning point in the modern energy market history of the US, when the shale gas started to be drilled for commercial reasons, and due to sufficient presence of experienced companies, the knowledge of geological structure and the pipeline network, the costs for shale gas drilling are lower than for natural gas drilling using conventional methods. This significantly influenced the price of natural gas in the US, which started to decrease immediatelly, with long-term tendency. Therefore we can say that US model is effective – both for producers and consumers.

9 Conclusion

To conclude, this Thesis provided full analysis of shale gas development in context of energy security of the EU. The goal of this work was to make updated research on shale gas, to explain its specifics, to prove the sufficiency of US model and to discuss the possible impacts on the EU energy market. Due to recency of topic, not many works had been written on this subject. In our work we have provided the literature review of all significant works, which are valuable for our research. The “shale revolution”, which occurred in the US, was complexly analyzed – the history, legal background, sufficiency, economic validity, and, born on EIA data, we discussed the prediction of evolving shale gas industry in the US. In our model we have proved that the unconventional methods are economically reasonable in the US, and contributed to decreasing of price on the US market. We have used data for all US states for 17 years in our model and we have concluded that shale industry has positive effect on US economy upon whole.

Since the energy politics was historically the concernment of separate sovereign countries, the pathway towards common energy security politics was not simple. All power delegations lead to partial loss of sovereignty. On the other hand, if the EU steps out as single unit, the bargaining power is much stronger. European countries result from different views on resources utilization and environmental issues. Function of energy security has been changing over the years – at the end of the WWII it was meant to avoid internal European conflicts, which became evident in highlighting international cooperation and in united energy market. The breakage in energy security reception raised in 1970s; due to world oil crisis the need of energy vulnerability decreasing raised up. Therefore the EU in last two decades has been adopting directives with declaration of interest in common energy politics; the most contributing was the Lisbon Treaty, which in 2009 entered into force and energy security reached the primary law.

The updated analysis of the EU energy market in context to shale revolution in the US was provided. The big enthusiasm in the EU for US model after gas crisis in 2009 led to evolving of plans for areal shale drilling in the EU. However, as we have pointed out, the multiple barriers for increasing the energy security by this way have risen. There is absence of skilled workers for service of shale wells facilities in the EU. Chance to find appropriately educated employees is from bad to worse even in the US for American companies in mining industry; in addition for reasonable price. Since this is rising problem in the US, we can presume the same problem (in worse scale) in the EU. Secondly, density of habitation is much higher in the EU than in the US, which increases the probability of local disfavor of drilling. Civil associations are organizing themselves, most significantly in Sweden, France, the Czech Republic, Romania and in some parts of Germany.

Densely populated area is afraid of unfavorable ecological impacts of this drilling, particularly resources of drinking water pollution. Shale gas drilling impacts on environment play one of the most important roles, particularly hydraulic fracturing of shale massifs with chemicals, sand and water. That brings risk of water resources contamination. This problem arises also in the US, therefore the US government representatives have already started to prepare legal standards. E.g. Parliament of state of New York has already prohibited using hydraulic fracturing of shale rocks on the territory of its state. This regulation will stay valid until the safety of shale gas drilling will be proved. Lastly, the West Virginian representatives have issued regulation significantly constraining possibility of drilling. European Commission has not made the appropriate legislation changes yet. Only the environmental official studies were done and regulation rules are kept to be made by sovereign countries at national level, until the more information on shale gas reserves will be available.

Initiation of shale gas drilling in the European Union could have far-reaching consequences for structure and functioning of European gas market. It can bring the higher role of consumer to the demand-supply relationship and lead to increasing of energy security of the EU. Another consequence could be higher integrity of global natural gas market, redirecting the LNG flows to new customers. Russian Gazprom, Italian, French, British mining companies could be competed with American concerns. Therefore liberalization of the European gas market would be logical spin-off of the EU shale gas production. The European Union is today one of the most valuable natural gas consumers in the world (together with China), so that the development of commercially usable shale gas drilling would stigmatize the equilibrium on European gas market. Arrival of US companies would bring significant weight of Russia as a strong energy player. We can generally observe the negative attitude of European (Gazprom) and Arabic suppliers towards the shale enthusiasm of the European Commission. Major energy companies in the EU oppose to shale gas drilling development, in form of lobbing at national governments or the EU representatives, or supporting the civil associations of public protests against exploration wells. All these forms of objection are using the security risks of shale plays drilling or environmental issues.

To be specific, we can summary the risks of potential shale gas drilling in Europe into few points:

- the absence of skilled companies and workers in the EU
- costing and complex technology needed (in compare to conventional plays)
- different attitude to property rights to land
- different geological structure
- higher density of population
- environmental issues in the EU
- negative public opinion
- developed existence of pipelines network across the EU and long-term contracts with Russia

We have to keep in mind that energy market, and particularly the oil and gas markets, is dynamic; commodity prices are evolving. Since the political situation in last decade is unstable, the unconventional methods are being used for commercial reasons less than decade and technology for shale gas drilling is still changing, the predictions for development in shale gas drilling industry evolve too. To understand completely the economic influences of shale revolution in the US, we will have to wait for at least one more decade. In context with energy security of the EU – process of legalizations and approvals of unconventional methods of drilling on EU territory will take years, and therefore we cannot expect the first commercial success of shale gas drilling before 2020.

In this context it is not presumptive that shale gas will cause revolution in the European energetics; the “shale revolution” is not going to happen in the EU. However European willing to support this boom in some countries will stigmatize the EU. Besides trying to follow American success we should also remember to deal with risks of this possible source of energy. This means the North American economy can still be based on oil and gas independently of stretch in world economy. The European Union will probably have to choose one of two scenarios – long-term dependency on fossil fuels import or costing transition to renewable resources of energy (together with nuclear-based power energy), which could be economically highly non-effective.

The UK, Hungary and possibly also other EU members will going to start the own “shale revolution” in few years. Therefore, there is a space for future research to study the model applied in these countries with additional data and predict the future of shale gas in the EU energy market. Finally, after Lisbon Treaty the “energy security” is term widely used in the EU legislation and qualitative research of effects of increasing emphasis on this term to future of the EU energy market should be done.

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11 Appendix

11.1 World price of natural gas, USD per thousand cubic meters

Date	Price
31.12.1991	1.85
31.12.1992	2.21
31.12.1993	2.12
31.12.1994	1.69
31.12.1995	2.67
31.12.1996	3.81
31.12.1997	2.33
31.12.1998	1.72
31.12.1999	2.35
31.12.2000	8.91
31.12.2001	2.42
31.12.2002	4.75
31.12.2003	6.14
31.12.2004	6.58
31.12.2005	13.5
31.12.2006	6.73
31.12.2007	7.13

31.12.2008	5.84
31.12.2009	5.35
31.12.2010	4.25
31.12.2011	3.16
31.12.2012	3.34
31.12.2013	4.19
31.12.2014	3.43

11.2 Statistics for two major US mining companies

Southwestern Energy

Chesapeake Energy

Cash flow from operating activities of Southwestern Energy, in thousand dollars

	2010	**2011**	**2012**	**2013**
Net cash flows from operations	1 908 528	1 653 942	1 739 817	1 642 585
Changes at operating activies and liabilities	75 272	-55 060	26 201	-62 906
Net cash flow	1 983 800	1 598 882	1 766 018	1 579 679

Source: own chart, data: Southwestern Energy

Fundamental production indicators of Chesapeake Energy

	2011	2012	2013
Net withdrawals, shale gas, billion cubic feet	1004	1129	1095
Total shale gas sales, million US dollars	4120	2011	2387
Total CNG sales, million US dollars	569	552	582
Average shale gas price, in US dollars per thousand cubic feet	4.77	2.07	2.23
CNG	38.12	29.37	27.87
Expenses on mining, Us dollars per BOE	5.39	5.50	4.74

Source: own chart, data: Chesapeake Energy Corporation Form 10-K

Cost-Revenue Statistics, Chesapeake Energy, 2009 – 2013, mil. US dollars

	2009	2010	2011	2012	2013
Total revenues	7702	9366	11 635	12 316	17 506
Total mining expenses	16 647	6561	8714	14010	15 437
Net profit/loss from fundamental operation	-8945	2805	2921	-1694	2069
Cash flow from fundamental operations	4356	5117	5903	2837	4614
Balance – total assets	29 914	37 179	41 835	41 611	41 782
Long-term debt	12 295	12 640	10 626	12 157	12 886
Total stock capital	12 341	15 264	17 961	17 896	18 140

Source: own chart, data: Chesapeake Energy Corporation Form 10-K

11.3 Overview of shale gas exploration in Europe (Broomfield, 2012)

United Kingdom

Date	Location	Description	Company	Status
Nov 2009	Preese Hall Farm, Weeton, Preston Lancashire	Exploratory well	Cuadrilla resources	Completed on 8 Dec 2010
Jan 2011	Grange Hill	Exploratory well	Cuadrilla resources	-
-	Anna's Road	Exploratory well	Cuadrilla resources	Planning approved
-	Balcombe well site (drilled by Conoco in 1986)	West Sussex license area held by its investment partner AJ Lucas.	Cuadrilla resources	No plans
-	Point of Ayr	Potential shale resource	Cuadrilla resources	review of hydrocarbon potential

Poland (hundreds of licenses have been granted)

Date	Location	Description	Company	Status
-	Milejow	adjacent to several blocks held by ExxonMobil, shale strategy and work program pending the	Dart Energy	Direct award license issued to Composite in

		outcome of shale drilling on nearby blocks		November 2010 Dart intends to undertake an independent resource certification exercise during 2011.
Sep 2011	Siennica	In the Lublin Basin, Exxon is operating in partnership with French oil major Total, which holds a 49% stake in the licenses. In the Podlasie Basin, Exxon has partnered with Hutton Energy.	ExxonMobil (ExxonMobil has six licenses to explore for shale gas in Poland.)	Initial drilling and hydraulic fracturing carried out at Krupe 1 and Siennica 1 wells. Reported to be not commercially viable.
2011	Baltic Basin	including Gdansk-W, Braniewo-S, Szczawno - with a pending application on the Czersk concession.	San Leon Energy with Talisman energy	drilling has been carried out at Rogity-1 well in February 2012.
2011	South-East Poland	Chevron conducted seismic programs and drilled an exploration well	Chevron Corp	
2011	-	Research of hydrocarbons in tight sands and shale	Cuadrilla Poland	Licenses for research of hydrocarbons in tight sands and shale have been awarded

2011	Siekierki Project (Block 207 & Block 208)	Testing Multi-stage fractured horizontal Wells T-2 and T-3	Aurelian Oil and Gas PLC	Final results were anticipated at the end of January 2012.
2010-2011	Baltic Basin	Łebień LE-2H horizontal well drilled Warblino LE-1H2 horizontal well drilled	3 sources (9 licenses) / Lane Energy Poland/ Conoco Phillips	A seven stage hydraulic fracture stimulation program was successfully executed across the 500 meters horizontal section in the deeper lower Palaeozoic shale.
2010	Baltic Basin	fracture stimulations were performed on both the Cambrian and Ordovician intervals in the Lebork S-1 well	BNK Petroleum (6 licenses)	Company plans to Re-stimulate Lebork S-1 well and stimulate Starogard and Wytowno wells
2010-2011	Zwola	hydraulic fracturing procedures is carried out by PGNiG SA in July 2010 in the Markowola-1 well in Zwola	PGNiG (15 licenses)	Company studies have highlighted no environmental issues

2011	Wejherowo	Lubocino-1 well near Wejherowo Tests carried out after completion of the fracturing operation indicate that there are potentially significant amounts of shale gas in the Wejherowo license area	PGNiG	PGNiG SA is the first Polish company to have commenced works towards commercial production of shale gas in Europe, aiming to commence production in 2014.
2011	Baltic Depression	The Company began drilling operations in the Łeczna and Siedlce districts in the fourth quarter of 2011,	Marathon Oil (11 concessions)	Early stages of exploring and evaluating the full potential of these holdings.

Germany

Date	Location	Description	Company	Status
2008-2011	Damme 3 Shale well	Testing Hydraulic Fracturing	ExxonMobil	Hydraulic Fracturing has been carried out; no environmental impacts reported by operator

2009-2010	- 2 concessions in North Rhine- Westphalia - concession in Lower Saxony - 2 concessions in Thuringia	geological survey / seismic survey	BNK Petroleum	Horizontal wells to be drilled not earlier than 2015
2010	concessions "Rhineland" and "Ruhr"	received permission	Wintershall	conduct geological investigations in two areas

France

Date	Location	Description	Company	Status
2010-2011	Nant (Aveyron)and Villeneuve-de- Berg (Ardèche) Montélimar	4,328 km2 concession awarded in 2010	Schuepbach Total/Devon	France has banned hydraulic fracturing for shale gas exploration and exploitation (June 2011)

Netherlands

Date	Location	Description	Company	Status
-	Boxtel	Planned exploratory well	Cuadrilla Resources	Drill activities suspended by

				court order

Bulgaria

Date	Location	Description	Company	Status
2015-2016	Shale gas deposit in a large section of Dobrudzha in the north east of the country	Planned two exploratory drillings in 2015 and two more in 2016.	Chevron Corp	Bulgarian government has imposed a ban on the use of hydraulic fracturing for oil and gas exploration and/or extraction on the Bulgarian territory (24th January 2012) and cancelled an exploration permit for shale gas exploration granted June 2011 to Chevron Corp (Jan 2012). Chevron can proceed with operations on the Novi Pazar concession in northeastern Bulgaria, but only by using conventional drilling techniques and not hydraulic fracturing

Norway

Date	Location	Description	Company	Status

2010	Alum Shale	-	-	The Norwegian Petroleum Directorate (NPD) confirms the existence of shale gas on the Norwegian shelf and onshore, but no plans for extraction.

Denmark

Date	Location	Description	Company	Status
2010	Bornholm	Scientific drilling to investigate natural gas in the Alum shale	GEUS (Geological Survey Denmark and Greenland), with GASH	-
2010	Nordjylland Nordsjælland	Two onshore licences to explore for subsurface oil and gas in Denmark were granted in 2010	Total E&P Denmark B.V., an affiliate of Total, and the Danish state-owned oil and gas company Nordsøfonden (2 exploration licenses)	The exploration licenses run from 2010 to 2016. Total E&P Denmark B.V. and Nordsøfonden are currently working on the first of three exploration phases. The full exploration process is due for completion in 2016.

Source: Broomfield (2012)

11.4 Interview with Michal Mareš (in Czech)

Audio record is attached to this Thesis.

Michal Mareš, specialista na energetiku, ekonomický úsek Českého zastupitelského úřadu v Moskvě, Ruská federace

Rozhovor proběhl dne 29. října 2014 na půdě českého velvyslanectví v Moskvě.

Přepis audio-záznamu.

Pane Mareši, Vy tedy máte zaměření na energetiku. Jak jste se k tomu dostal?

No prostě jsem se rozhodl, že mě to baví.

Na škole?

Ano, na vysoké škole. Jsou tam peníze, je to zajímavé, je v tom trochu politika, tak jsem si řekl, proč se nezabývat energetikou. Přihlásil jsem se do výběrového řízení na Úřad vlády, před předsednictvím a vyšlo to. Ale už jsem se tomu věnoval na škole, protože tam byla ta možnost.

Jak vnímáte pojem „*energetická bezpečnost*", co to pro vás znamená?

Na to jsem psal dokonce diplomovou práci. Na téma Diverzifikace exportních směrů, a první teoretická část byla přímo k pojmu „energetická bezpečnost". Energetická bezpečnost určitě není jenom jeden pojem. Liší se to v tom, jak ten pojem chápou státy, které jsou závislé na dovozu energetických surovin a odlišně ji chápou státy, které jsou závislé na exportu těch surovin. A ještě trochu jinak ho chápou tranzitní země, nicméně z mého pohledu nevytváří žádný nový přístup, i když jsou to země tranzitní, buď jsou čistí exportéři, nebo čistí importéři, a podle toho chápou svou energetickou bezpečnost. To velmi zkráceně a zjednodušeně znamená, že když jste závislý na dovozu, jste spotřebitelský stát, tak je to o tom, abyste si v jakékoliv době byl schopen zajistit potřebné množství energetických surovin za rozumnou cenu. Pak je nutné definovat, co je rozumné cena, což se dá definovat jako cena, která neohrožuje funkce státu a nemá negativní vliv na jeho ekonomiku. To je ovšem pouze velmi zjednodušená definice. Potom jsou tam další věci, které je nutné definovat. To, co znamená ten daný okamžik. Protože v daném čase je to dostatečné množství za rozumnou cenu, ale je otázka, co je to ten daný okamžik. Za normální situace jsou běžné dodávky, pak jsou chvíle, kdy nastane nějaká krize, pak je potřeba zajistit obyvatelstvo, také aby dodávka neměla vliv na fungování státu, aby záchranný systém měl svoje dodávky. Ale to už jsou specifické krizové stavy. V zásadě pro definici toho pojmu energetická bezpečnost se s tím dá pracovat. Tzn. energetická bezpečnosti v rámci běžného stavu a energetická bezpečnost v rámci krizového období. A to třeba máme definované i v našich zákonech, to jsou tzv. stavy nouze – co se týče plynárenského sektoru, jací zákazníci dostávají primárně dodávky, a jací můžou být odpojovaní.

Takže je nastavený seznam přednostních odběratelů?

Dokonce je to definovaný pojem v zákoně, o chránění odběratele. Samozřejmě jako první se odpojují průmyslové podniky, které mají vliv na ekonomiku, ale nemají vliv na zdraví lidí. Lidé sice nebudou v práci, ale doma si zatopí. Ale to je v zákoně. Takže v podstatě, abych to shrnul, co se týče energetické bezpečnosti, z pohledu státu, který je importérem, je to schopnost zajistit si dostatečné množství energetických surovin, a to je o tom, o čem jsme se bavili, dostatečné množství pro zajištění základního chodu státu a jeho složek za rozumnou cenu a je potřeba definovat, co je to ta rozumná cena.

A vy jste zmiňoval, že ten pojem znamená něco jiného pro importéry, a něco jiného pro exportéry. Já si to dříve spojoval vyloženě např. s Českou republikou, jako čistým importérem a spíš se zeměmi, které odebírají plyn a ropu a nikdy jsem si to nespojoval se zeměmi jako třeba Rusko. Co znamená energetická bezpečnost pro Rusko? Vnímá ho hlavně jako na potřebu zajistit příjem do státního rozpočtu?

V zásadě ano. Protože když se podíváte na rozpočet velkých producentů surovin, tak jejich rozpočet je závislý na exportu ropy nebo plynu. Takže pro ně EB znamená jednak zajistit dostatek energie pro své obyvatelstvo, to je stejné, ale druhá věc je zajistit dostatečný odběr svých surovin – samotnou těžbu a její finanční i technickou stránku, a také zajistit export v dostatečném množství a za dostatečně vysokou cenu, takovou aby to dokázalo saturovat základní potřeby, které se od toho očekávají, ale nesmí být cena neúměrně vysoká. Protože kdyby byla až moc vysoká, tak by to zákazník přestal kupovat a hledal by alternativní cesty, tak by to ve výsledku poškozoval i exportéra. To znamená, že pro exportéra je dobré, když ty ceny budou nejvyšší. Je tam průsečík, který neomezuje ani import, ani export, a je přijatelný pro obě dvě strany. Ani když je cena moc nízko, tak to není dobře, protože to poškozuje exportní státy a ty potom můžou začít omezovat těžbu. Na tom trhu je pak nedostatek suroviny, cena vyletí nahoru a tím se to reguluje. Ale to není ani to ani příliš vysoká cena, protože to potom poškozuje státy, které to odebírají, ty začnou omezovat množství a začnou vymýšlet, jak se zabezpečit jinak. Takže v podstatě ten trh se někde protne, a to většinou bývá aktuální cena.

Máte představu, kolik příjmů do státního rozpočtu Ruska plyne z energií?

Z hlavy si to přesně pamatuji, ale je to kolem 50%. A export ropy a plynu činí nějakých 75-80% z veškerého exportu. Co se ale týče toho příjmu, tak je to 50, přes 50%. Což je samozřejmě ohromné číslo.

V kontextu EU – máme pojmy potravinová bezpečnost, energetická bezpečnost. Jak velký se klade důraz v EU na to, aby byla zajištěna energetická bezpečnost, aby byl zajištěn stálý přísun ropy a plynu? Jak moc se EU potažmo ČR bojí o budoucnost odběrů, nebo vnímá tuto situaci stabilně? V posledním půlroce je to všelijaké.

Já si nemyslím, že v posledním roce je to všelijaké, vždycky to závisí na tom daném státu. Ještě abychom si řekli, jaké zajištění dělat pro energetickou bezpečnost, tak by bylo dobré si definovat hrozby energetické bezpečnosti. Těch je mnoho kategorií – politické, technické, ekonomické, finanční, sociologické, např. korupce. Ať už se to týká vzdělanosti a know-how personálu nebo firem, které se pohybují v energetickém sektoru, těch hrozeb je celá řada, podle různých kategorií. Můžou to být v podstatě v nějakém případě i politická hnutí, např. „zelení“, která brání výstavbě nějakých objektů. Ale nelze to zobecňovat, a brát to tak, že zelení jsou hrozbou pro energetickou bezpečnost, to určitě ne, ale když se podíváme na škálu těch hrozeb, tak v nějakém stupni to může být i nějaká iniciativa, která brání výstavbě projektu, který je pro danou lokalitu velmi významný. Ale ta otázka zněla jinak. Upřímně, já jsem přesvědčený o tom, že politika ještě před finanční krizí 2009 byla v EU nastavená tak, že máme hodně peněz, jsme na špici vývoje a my musíme jít příkladem ostatnímu světu, s tím že jsme ochotní vkládat obrovské množství prostředků do technologií, které nejsou úplně efektivní, které nejsou úplně v tento moment energetickou bezpečnost dostatečně zajistit, ale jsou řekněme přívětivé k životnímu prostředí a my budeme tím příkladem, že se vyplatí do těchto technologií nalévat obrovské peníze. A případně to, co nebudeme schopni zajistit těmito obnovitelnými zdroji, tak budeme schopni za velké peníze to odněkud dovézt do země. A tady ta politika se bohužel nezměnila ani po finanční krizi. Dnes je už jasné, že to, co jsme chtěli implementovat v Evropě, v tom nás svět následovat nebude. Z logiky věci – pro Čínu, pro Indii, pro tyto velké rozvojové země je samozřejmě důležité co nejdříve dospět ke standardům, které jsou běžné v Evropě a US. To znamená, že každý chce mít doma elelektrický přístroj, každý si chce svítit a topit. A tím našim příkladem vysvětlovat Číňanům, aby vypnuli uhelné elektrárny, aby nestavěli další tepelné elektrárny, aby raději stavěli větrné, nebo i třeba jaderné elektrárny, které avšak v tak krátkém čase nedokážou zajistit potřebné množství elektřiny pro obyvatelstvo, jehož životní úroveň samozřejmě stoupá, a požaduje větší množství elektřiny, je trochu pokrytecké. My to sice máme, ale vy to nebudete mít hned, - počkejte si a šetřete si životní prostředí. To však neplatí. O tomto začnou ty země přemýšlet, až když mají zajištěné veškeré svoje potřeby a můžou si to dovolit, ale ve chvíli, kdy spousta lidí nemá přístup vůbec k elektrické energii, nebo jenom v omezené míře, tak jim vysvětlovat, že není třeba té elektřiny spotřebovávat tolik, je zbytečné. Takže to samozřejmě nezafungovalo, evropský příklad nikdo nenásledoval, nebo jen v omezené míře, a my dneska v Evropě si to nemůžeme dovolit, protože ty peníze v EU od roku 2009 prostě nejsou, nebo jsou potřeba na jiné věci. A Evropa je dnes v takovém stavu, kdy žádný investor, ani evropský ani zahraniční, nechce investovat do nového zařízení na výrobu elektřiny, protože se mu to nevyplatí. Naše politika podpory obnovitelných zdrojů totálně zdeformovala trh a dnes když nemáte zdroj, který není dotovaný, což jsou pouze obnovitelné zdroje, tak se vám nevyplatí ani uhelná elektrárna, která je ještě na černé nule. Ale když budete stavět elektrárnu na kvalitnější černé uhlí, se všemi technologiemi, aby to znečišťovalo životní prostředí co nejméně, tak se vám to nevyplatí, stejně jako plynová elektrárna, protože ten výkon není potřeba. Nevyplatí se vám postavit ani jaderná elektrárna, přestože fungující jaderné elektrárny dnes vyrábí elektřinu za minimální cenu. Cena jedné kWh vyrobené v Dukovanech nebo v Temelíně je několik desítek halířů. Cena za stejné množství elektřiny vyrobené ve větrnících je asi 13 korun. Přesto se vám nevyplatí jaderná elektrárna postavit, protože podporované zdroje v podstatě se rozšířily, snížily cenu elektřiny, ale snížily cenu elektřiny ve chvíli, kdy jsou ty zdroje funkční. Když svítí slunce, fouká vítr, tak elektřiny je nadbytek a na burze technicky někdy dosahuje záporných cen, protože to jsou třeba ve chvílích, kdy není takový odběr, kdy elektřina není potřeba. A samozřejmě potom například u elektrárny, která běží kontinuálně, máte nadbytek elektřiny, kterou nemůžete prodat a musíte ji prodávat pod cenou, a pak se vám nevyplatí, aby vám ta elektrárna běžela, nebo abyste ji stavěli. Protože ve chvíli, kdy je v síti plno elektřiny z obnovitelných zdrojů, tak ještě navíc dnes máme v Evropě takovou legislativu, že je nutné brát elektřinu z těchto obnovitelných zdrojů přednostně, tak vám nezbude nic jiného, než tu vaši elektrárnu vypnout. A když potom ve výsledku v tom roce na tom tratíte, tak do toho nebudete investovat. Ale pak jsou chvíle, kdy nefouká a nesvítí, ale vy tu elektřinu potřebujete. A když budete mít nové zdroje, tak kde ji vezmete?

Chápu to tedy tak, že se stavíte negativně k větrným elektrárnám, solárním panelům a podobně?

Určitě je to dobrý doplňkový zdroj – například solární panely na jednotlivých domech. Nebo ve Španělsku, kde svítí slunce pořád.

Solární panely tedy mají větší význam na jihu Evropy.

Přesně tak, musí se přihlédnout k našim podmínkám. Tak, aby ten zdroj byl co nejstabilnější. Ve chvíli, kdy to postavíte v našich podmínkách, tak ty výkyvy jsou tam hrozné a vy stejně musíte držet nějaké záložní zdroje, tzn. plynovou nebo uhelnou elektrárnu, která vám většinu doby bude stát, což vás bude stát obrovské peníze. A žádný soukromý investor to neudělá, protože na tom bude tratit. Takže se dnes dostáváte v Evropě do situace, že se nevyplatí kromě podporovaných, tj. obnovitelných zdrojů, stavět nic nového. Politika v EU je taková, že než by zrušila podporu obnovitelných zdrojů, tak je pro ni přijatelnější i ve chvíli, kdy EU nemá peníze, povolit podporu pro další typy energií tak, aby byly realizovatelné. Takže se ve výsledku dostanete do absurdní situace, jako jste byli na začátku, že všechny zdroje – obnovitelné i normální – jsou na tom stejně, ale na začátku jste nepodporoval žádný, a na konci budete podporovat všechny. Takže budete vydávat obrovské peníze a dostanete se do stejné situace, což je politika. A vychází se z toho evropského nadšení, které bylo v době konjunktury kolem let 2005-2007, kdy se zdálo, že máme nevyčerpatelné zdroje a že si toto můžeme dovolit. Protože v zásadě dnes je nastoupená cesta hledání nových technologií a investice do nich, které jsou samozřejmě čistší, přívětivější k životnímu prostředí, úspornější, a to je správná cesta, nicméně my to děláme zvráceně. My dnes máme technologie, které jsou fungující, ale které nejsou ani z ekonomického hlediska, ani z hlediska energetické bezpečnosti, bezpečnosti dodávek, efektivní. My naléváme peníze do implementace technologií, o kterých víme, že jsou neefektivní. Místo abychom vzali peníze a investovali jsme je do výzkumu. Abychom ty technologie zdokonalili tak, aby efektivní byly, z ekonomického i bezpečnostního hlediska. A Evropská komise žije podle mě v situaci z let 2005-2007, kdy tu byly obrovské zdroje a mohli jsme si to dovolit. Dnes tu ty zdroje nejsou a tato politika je naprosto zvrácená. Elektrárny v Evropě vznikaly v 50., 60. letech a dnes dojíždí. Dnes je mnoho evropských elektráren na konci své životnosti. A jsme v situaci, kdy nikdo nic nestaví a nemodernizuje. Všichni vyčkávají, jaká bude politika Evropské komise. Co bude a co nebude možné podporovat. Nejedná se o to, co bude konkurenceschopné v tržních podmínkách, nýbrž o to, že my nemáme jednotný trh. Máme deformované prostředí, kde tržní zásady nefungují. V tomto smyslu je otázka energetické bezpečnosti v EU poměrně zvláštní, protože si EU podkopává vlastní stav, který byl poměrně uspokojivý. Jsme zahledění do sebe a máme pocit, že budeme něco dělat a všichni se budou podle nás řídit. Ale už vidíme, že nám začíná ujíždět vlak. Všichni dělají to, co je pro ně nejefektivnější – ať už z finančního, bezpečnostního hlediska nebo hlediska životního prostředí. A to je trojúhelník, který musí být vyvážený. A když máte jednu hranu trojúhelníku, kdy to bude super pro životní prostředí, ale nedokáže vám to zajistit dodávky a ještě je to drahé, tak to nejde. Musíte skloubit všechny hrany trojúhelníku, co se týče bezpečnosti, ekonomické efektivity a samozřejmě přijatelnosti pro ochranu životního prostředí. A nejde podporovat jen jednu hranu, co dělá Evropská komise. Už dva roky je na tom zaseklá a všichni to vidí. A z nějakého nepochopitelného důvodu se nemůže pohnout dál. A když se podíváme na jednání Evropské rady, kdy mnoho států tlačilo na závazné emisní cíle, místo toho aby se tam kladla jednoduchá otázka, jak zajistit energetickou bezpečnost a rovnovážný energetický trh v Evropě. A žijeme ve vzdušných zámcích, kdy se bavíme jen o detailech jedné oblasti, ale nebereme v potaz finanční stránku, jako kdybychom měli neomezené zdroje a také na stránku zajištění dodávek energií, což je z mého pohledu velmi špatná politika. A podle mě, pokud nepřijde razantní krize, tak se nic nezmění.

Ta krize tedy zatím nepřišla?

Určitě ne. Mrznul jste doma? Zažil jste doma výpadek, že vám doma den nešla elektřina? Tak vidíte. Ještě se vrátím na začátek – z mého pohledu se EU jako celek reálně nezabývá otázkou zajištění energetické bezpečnosti tak, jak to chápeme my v základní definici. Zabývá se pouze určitou částí toho, čemu se říká energetická bezpečnost, zaměřenou na obnovitelné zdroje, ale naprosto ignorujeme většinu toho pojmu. V zásadě je to ponechané na jednotlivých státech. Na jedné straně je energetika sdílená kompetence. To znamená, že jsou za ni zodpovědné jednotlivé členské státy, a je na těch státech, jak si bezpečnost zajistí. Samozřejmě, Evropská komise tomu dává rámec, ve kterém se musí ty státy pohybovat.

Takže EU na energetickou bezpečnost důraz neklade.

Ne, tak jak ji chápeme my, jako ten trojúhelník, tím se Evropská komise téměř nezabývá, ale částečně je to dané tím, že je to v kompetenci jednotlivých států.

A Česká republika se tím zabývá?

Řekl bych, že ano. Stoprocentně víc než EU. Ale to je logické – ve chvíli, kdy je tahle kompetence v rukou jednotlivých členských zemí, tak je to na nich, aby si tu energetickou bezpečnost zajistili. Z mého pohledu je to proto, že nejsme schopni se dohodnout. A ty státy nevěří tomu, že Komise by za ně rozhodovala lépe a zajistila energetickou bezpečnost lépe, než by to udělaly samy. To je ale chyba u tak velkého projektu, jako je Evropská unie. A mělo by to fungovat tak, že když to budou všichni zajišťovat společně, všech 28 států, tak budou mít daleko větší váhu, než když si to ČR bude zajišťovat sama. Možná to neplatí pro Británii nebo pro Německo, ale pro drtivou většinu zemí to platí, a to i pro velké země, jako pro Itálii a podobně. Evropská komise se tím moc nezabývá, ale pouze z toho důvodu, že nemá tu pravomoc. Nicméně vytváří legislativní prostředí, ve kterém se musí pohybovat jednotlivé členské země při zajišťování energetické bezpečnosti, a bohužel to z mého pohledu legislativní prostředí do značné míry členským zemím dost komplikuje. To je problém. Není problém to, že se tím EU nezabývá. Ona se tím ani zabývat nemůže, protože nemá ty kompetence. Členské státy si řekly, že tu pravomoc do Bruselu nepřesunou.

Měla by Česká republika hledat nějaké alternativní zdroje? Máme uhelné elektrárny, vodní, jaderné... Měla by ČR hledat další alternativy, např. nové zahraniční partnery pro odběr energií, nebo sama by měla vyvíjet nějakou další činnost?

Osobně si myslím, že ČR patří do nejlepší třetiny v rámci EU, které se aktivně starají a zajišťují svoji energetickou bezpečnost. Myslím si, že máme dobře nastavený energetický mix. Ten musí vycházet vždy ne z politických cílů, ale musí odpovídat geografické poloze, finančním možnostem, schopnosti bezpečně si zajistit dodávku. Což my máme – většinu máme z uhelných elektráren, plyn je stále doplňkovým zdrojem i pro centrální vytápění. Máme jaderné elektrárny, jsme na hraně toho, co jsme schopni využít z obnovitelných zdrojů, což je samozřejmě správně. Ale dneska ČR stojí na hraně, kde jsou před koncem životnosti některé významné uhelné elektrárny, které bude potřeba nahradit, a protože se zdá, že EU formuje energetický trh, a to legislativní prostředí tak, aby uhlí jako špinavý zdroj v energetice nebylo používané, tak se musíme ohlédnout na to, co pro nás bude nejlepší v budoucnu. A já jsem přesvědčený o tom, že pro ČR v budoucnu bude nejlepší, nebo alespoň na základě technologií, které jsou dnes dostupné, rozšiřování podílu jaderné energie. Jednak je to čistá energie, také je to levná energie, a to říkám s vědomím těch velkých investičních nákladů na začátku, ale když si vezmete, že je to projekt na 60 let, a po tuto dobu vám bude elektrárna vyrábět elektřinu, tak ta výroba z jaderného zdroje je velice levná a dnes jednoznačně je nejlevnější. To, že dnes je v zásadě deformovaný trh a že ceny elektřiny jsou tak nízko, že i za takto dlouhý cyklus se nedokážou vrátit i nějaké investiční náklady a těmto investorům se do toho nechce, to je jiná věc. Ty ceny jsou tak nízko, protože na to doplácíme všichni, ale z jiné kapsy. Neplatíme to přímo v ceně za elektřinu, ale platíme to v jiných ekologických poplatcích, nebo v daních, které stát potom zpětně dává jako podporu. Takže to je umělé snižování ceny. Sice vidíme na účtu, že cena elektřiny je levná, tak tomu všichni tleskáme, ale z těch daní se to dotuje, aby to potom bylo levné na té účtence. To je třeba si uvědomit. Jak jsem říkal – ten výrobní náklad jednotky z jaderné elektrárny, a z větrné elektrárny, které máme v ČR, je několik desítek halířů versus 13 korun. Ale ve výsledku si řeknete, jak máme levnou elektřinu, přestože bychom většinu vyráběli z obnovitelných zdrojů a neměli bychom tu jadernou. Což je naprosto nesmyslné. Ale to je to legislativní prostředí, které vytváří Evropské komise. Ona ho vytvoří a poté řekne – to je vaše kompetence, starejte se, o to zajištění. Ale abych neodbíhal – myslím si, že ano, ČR je v tomto aktivní. Vzhledem k podmínkám máme dobře nastavený energetický mix a přemýšlíme co dál. Existuje státní energetická koncepce, v současné době Ministerstvo průmyslu a obchodu pracuje na její aktualizaci. Když se vrátíme k ropě a plynu – jsme velmi aktivní – postavili jsme ropovod IKL, máme tedy dnes alternativní cestu pro případ, že by vypadly dodávky ropy z východního směru přes Ukrajinu, tak můžeme dovážet přes Itálii, Rakousko a Německo. Už několikrát se ukázalo, že to bylo velmi dobré rozhodnutí, protože už několikrát došlo k výpadku dodávek z východu. A jenom díky této infrastruktuře jsme byli schopni dodávky nahradit. A to je ve srovnání se zbytkem Evropy poměrně výjimečná záležitost. A my jsme se dokázali diverzifikovat v ropě i v plynu, postavili jsme plynovod Gazela, takže máme infrastrukturu na to, abychom dostávali značné množství dodávek ze západního směru – ruských i norských. Takže Česká republika má svou bezpečnost zajištěnou velmi dobře, ve srovnání s ostatními státy, ale jen protože pro to něco udělala. Například Bulharsko křičí, že nemá alternativu v dodávkách plynu – když vypadne cesta přes Ukrajinu, tak budou mrznout stejně, jako se to už stalo v roce 2009. A od roku 2009 debatují o tom, jak postavit plynovou propojku do Řecka. Ještě to neudělali. Ta propojka stojí asi 30 mil. euro, což z pohledu státního rozpočtu a z pohledu ztrát, které vám vzniknou, když vypadne jediná cesta dodávek, je zanedbatelné. Bulharsko se tak nediverzifikovalo jako například Česká republika. Takže je to o přístupu jednotlivých zemí. U nás je energetická bezpečnost téma a dává se na to velký důraz – v ministerstvech financí, průmyslu a obchodu, zahraničí. Když se podíváte na jiné státy, tak jsme na špičce.

Chápu správně, že pokud by došlo k totálnímu výpadku dodávek plynu z Ruska přes Slovensko, tak jsme schopni ho nahradit jinými plynovody?

My ano. Česká republika je schopna to nahradit, těmi existujícími plynovody. Na druhou stranu – nic není stoprocentní. Infrastruktura, která existuje, by samozřejmě byla využívána i pro mnoho dalších států. Takže říct, že stoprocentně bychom si vzali tu potřebu, kterou my máme a dalším státům bychom dali jen to, co zbude – to nelze. Ale kapacitně jsme ty trubky postavili tak, aby tu ta možnost byla.

Česká republika je srdce Evropy – a co se plynu týče, je naprosto závislá na Rusku.

To není pravda. V plynu je to z 50%, v ropě zhruba ze 60%.

Dobře, tak tedy většinově závislá.

No ale většinově a stoprocentně je velký rozdíl. Když berete z Ruska půlku, tak tou druhou půlkou to nahradíte. Když berete jen z Ruska, a navíc jednou trubkou, tak to prostě nenahradíte.

Vnímáte to jako problém, to že jsme většinově závislí co se ropy a plynu týče na Rusku? Neměl by ten stát být více diverzifikovaný?

Vždycky je lepší, když těch dodavatelů máte víc. Ale také vždycky je to otázka cena – kolik jste ochotni za to utratit. Polsko si postavilo terminál na příjem zkapalněného plynu LNG, což zvýšilo jejich bezpečnost. Ale ten plyn, co mají nasmlouvaný, je dvojnásobně dražší než plyn, který mají z Ruska na základě dlouhodobé smlouvy.

A od koho chtějí kupovat zkapalněný plyn?

Mají kontrakt s Katarem. A baví se s Katarem, jak to co nejvíce zlevnit. A vždycky je to na vás, kolik jste ochotni utratit. A abych odpověděl na tu otázku – nemůžeme být stoprocentně závislí na Rusku, to by byla velká chyba. Ale to nejsme. Takže musíme být diverzifikovaní a musíme mít záložní dodavatele. A musíme mít také diverzifikované cesty, kterými se k nám můžou dostat ty suroviny, z východu i ze západu. A to máme – jak v ropě, tak v plynu. Určitě by bylo špatně, kdybychom neprodloužili kontrakty, které máme – např. na norský plyn, který nevyužíváme, a nakupujeme na spotových trzích v Německu, ale jako záložní varianta je to velmi dobré a ukázalo se to i v roce 2009, že je to velmi dobré. A kdyby ten kontrakt měl skončit a nebyl by obnoven a zase by stoupnul podíl ruského plynu, tak by to bylo špatně. Ale v situaci, v jaké jsme dnes, kdy v případě výpadku ruského plynu jsme schopni si zajistit jiného dodavatele, a to jak co se týče suroviny, tak i přepravní cesty, tak je to v pořádku. A jestli toho ruského plynu odebíráme 40 nebo 60 %, je v zásadě jedno. Když máte cestu a alternativního dodavatele, který v případě výpadku je schopen vám to nahradit. Ale musíte mít cestu, a to něco stojí. Jako v již zmíněném příkladu s Bulharskem a Řeckem. Oni nebyli ochotni za toto utrácet, a teď se bojí, že když bude problém a vypadnou dodávky přes Ukrajinu, tak vymrznou v Bulharsku, protože nebyli ochotni investovat v zásadě malou částku na zvýšení energetické bezpečnosti, což naopak ČR investuje. A ČR investuje dlouhodobě, nejen kvůli krizi 2009, ale v podstatě IKL byl spuštěný tuším v roce 1996, a Gazela v roce 2013, a přípravy na to započaly ještě dlouho před rokem 2009, protože to chvilku trvá. Chcete postavit nový plynovod nebo ropovod. To není jednoduché. Je na to evropská legislativa a proces je to komplikovaný. Není to jako Čína, která natáhla sedm tisíc dlouhý plynovod do střední Asie během dvou a půl roku. U nás dva a půl roku běží jenom řízení o dopadu na životní prostředí. Sami si to ztěžujeme. U nás je tedy výstavba infrastruktury zdlouhavá. A samozřejmě je náročná i z jiného pohledu – nemáte legislativu, kde máte strategickou infrastrukturu, kterou chcete postavit – ať už jsou to železniční koridory, energetické záležitosti nebo cokoliv jiného – ale to se dá upravit vnitrostátní legislativou té země a je to na každém tom státu, jak kvalitní má legislativu, podle které se potom řídí. Ale myslím si, že tak, jak to máme nastavené dnes, dodávky z Ruska nejsou problém, protože máme alternativu. Ve chvíli, kdybychom ji neměli, tak by to problém byl, že bereme plyn z Ruska. A to ať co se týče suroviny, nebo i přepravních cest.

Když se podíváme na břidlicový plyn – v US nastal obrovský boom těžby této suroviny před osmi, deseti lety, vidíte v něm budoucnost? Myslíte si, že se to může vyplatit a má to smysl?

Přiznám se, že nemám informace o podloží, kde se to těží, takže nedokážu říct, jak dlouho dokážete čerpat z jednoho naleziště. Ale kdyby se to nevyplatilo, tak se to netěží. V US ta surovina dotovaná není a ty ceny se pohybují v podstatě kolem 3,5-4,5 dolarů za MMBTu, kdežto v Evropě je to 10-12 za stejnou jednotku. A tam to nikdo nedotuje, tam jsou to soukromé společnosti, které to těží a prodávají to za tuto cenu, a pořád se jim to vyplatí. Ale samozřejmě o břidlicovém plynu se nedá mluvit obecně. Když se to vyplácí v Americe, tak se to nemusí vyplácet těžit v Evropě, v Rusku nebo v Číně. Protože geologické podmínky, ve kterých se ten plyn nachází, jsou různé. A cena, při které se to dá těžit v US, rozhodně není cena, při které by se dal těžit ten plyn v Rusku nebo v Číně, a to s ohledem na geologické podmínky. Pak existují různé právní podmínky – v US je úplně jiná legislativa ve srovnání s Evropou. Takže když chcete těžit v Americe, tak tam nemáte takové administrativní bariéry, jako jsou v Evropě, kdy díky evropské legislativě je to velmi složité, vůbec začít pouštět chemikálie do země, i co se týče vlastnického práva, jak můžete nakládat s pozemkem a s tím, co leží pod ním.

A v čem se to tedy liší mezi EU a US?

Nejsem odborník na právo, takže nedokážu přesně říct.

Ale to co je pod zemí, tak u nás přece patří státu, je to tak?

Ano. Ale jak říkám, nejsem odborník na právo. Jsou tam však i další rozdíly – v US jsou obrovské nezalidněné plochy, kde se to dá těžit. V Evropě tomu tak není, máme tu jednu vesničku vedle druhé. Takže podmínky jsou jiné, nejenom geologické, legislativní, dále hustota zalidnění a podobně. Samozřejmě také i finanční a technologické. V US je mnoho firem, které znají ty technologie, v Evropě jsou také nějaké, ale v Rusku už ty firmy nejsou. Takže – ano, břidlicový plyn má budoucnost, všude po světě jsou obrovské zásoby, ale ne všude jsou ty zásoby těžitelné v dnešních podmínkách a při dnešních cenách.

V Evropské unii to tedy je možné nebo není?

V EU si myslím, že to ve velkých objemech v současné době možné není. Některé země, např. Francie, si legislativou zakázaly to, že budou těžit břidlicový plyn. Pak tu máme přísnější ekologické předpisy, než jsou v US. Ani nevím, jaké je v Evropě podloží, jestli se blíží tomu, co je v Rusku, takže by ty náklady na těžbu byly daleko vyšší, nebo se blíží tomu, co je v US, kde opravdu je to tak poskládané, že je to levné...

Proč jsou v Rusku vyšší náklady na těžbu?

To je dané geologicky, v Rusku je úplně jiné podloží, jsou tu jiné horniny a musíte vyvinout mnohem vyšší úsilí, abyste ten plyn z břidlice dostal.

A v Rusku se mluví o těžbě břidlicového plynu?

Mluví. V tom smyslu, že Američané jsou pitomci, protože nemůže hrát žádnou roli. Což není pravda, což se ukazuje, a globálně to má vliv na cenu plynu a suroviny. Takže to není tak, že by to nemělo vliv. I tím, že to sníží cenu pro americké odběratele, kteří jsou potom více konkurenceschopní a můžou uplatnit svoje výrobky na nějakých trzích, kde dřív nemohli kvůli ceně, takže ten vliv to má velký. V Rusku jsou debaty o břidlicovém plynu, ale naleziště konvenčního klasického plynu jsou dnes těžitelné levněji, než kdyby se rozvíjela těžba břidlicového plynu.

Rusko má přece postavené základy, má vybudovaný systém potrubí...

To ani ne, protože jak naleziště břidlicového plynu, tak nová naleziště konvenčního plynu jsou mimo současnou vybudovanou infrastrukturu, takže stejně se musí postavit všechno znova. Nicméně je ten konvenční plyn stále levněji těžitelný. Ať už co se týče geologie, nebo technologie, kterou na to potřebujete. Protože oni ty zásoby mají, ale v zásadě to nevyužívají, protože by se to nezaplatilo. Ve chvíli, kdy by cena vyskočila nahoru, protože ještě pořád jsou ceny plynu vázané většinou na cenu ropy, i když i to se mění rychle. Pokud cena ropy vyskočí o 100 dolarů, tak možná ty ceny budou efektivně těžitelné v Rusku, ale při těchto cenách se vyplatí rozvíjet jiná naleziště než naleziště břidlicového plynu.

A v US se to tedy vyplatilo díky odlišnému podloží?

Ano, a nejenom. Jsou tam jiné geologické, právní, technologické podmínky. Není to tak, že když máte břidlicový plyn, tak to bude pokaždé stejné. Dostáváte ho ze země pokaždé za jiných podmínek. V US to nikdo nedotuje, jsou technologicky tak vyspělí, že se jim to vyplatí za poměrně nízkou cenu. Ale dostávají ten plyn většinou na nalezištích, kde se nalézá i ropa, a už netěží z nalezišť, kde je pouze suchý plyn, a není tam žádný kondenzát, protože to by se jim nevyplácelo. Těží tak plyn pouze jako asociovanou surovinu k ropě. Takže ty podmínky jsou strašně jiné v každé části světa. Jak geologické, tak legislativní, tak technologické a ne všude se vám to vyplatí. Břidlicový plyn – to není jen jeden pojem.

Myslíte si, že se vyplatí dovážet plyn z US do Evropy, ve zkapalněné formě? Mluvil jste o tom, že ČR má záložní plán pro případ výpadku plynu z východní strany. Jednotlivé země EU také hledají záložní zdroje, a přímořské země zvažují vybudování terminálů pro příjem zkapalněného plynu, jako například již zmíněné Polsko. Vyplatilo by se to?

Ty terminály už existují, nejsou však využívány na plnou kapacitu. Máme poměrně značnou volnou kapacitu evropských terminálů na příjem zkapalněného plynu. Ale je to otázka ceny. Dnes je ta cena taková, že se zemím vyplatí využívat jiný zdroj a plyn ve zkapalněné formě nenakupovat, protože je drahý. A cenu zkapalněného plynu na světovém trhu zvyšuje asijská spotřeba. Na asijském trhu, kde je plynu nedostatek, a dostává se tam formou LNG, je ta cena vysoká a ta ovlivňuje cenu komoditu v dalších částech světa. Zatímco v Evropě je ta cena nastavená kolem 10-12 dolarů za MMBTu, tak v Asii je to 17 až 18, někdy i 20. Takže proč by to producent prodával do Evropy, když v Asii za to dostane dvakrát tolik? A když bude v Evropě poptávka po LNG, tak producent bude souhlasit, ale jen za cenu 18 až 20 MMBTu. A když nejste v krizové situaci, tak není důvod takto drahý plyn kupovat. Proto se kupuje ze zdroje, který je v tu chvíli dostupný za nižší cenu. Ale to, že terminály jsou vybudované, tak samozřejmě stálo nějaké peníze, teď se to k dnešnímu dni tolik nevyužívá, ale v minulosti se už stávalo, kdy ta kapacita byla plná, a v budoucnu se to stane zase. A máte tu možnost. Ve chvíli, kdy by ty terminály nebyly, tak jste odkázán na jeden zdroj – na potrubí, které k vám jde, a samozřejmě je v ten moment vyšší cena toho potrubního zdroje – protože když nemáte jinou možnost, tak vám dodavatel zvýší cenu. Ale když je tam nějaká konkurence, tak to tlačí na cenu toho plynu, takže je důležité, že terminály jsou vybudované a využijí se ve chvíli, kdy jsou potřeba. Jsou plány na další terminály, které většinou staví soukromí investoři.

Jak vidíte problematiku vyčerpání neobnovitelných zdrojů? Už se o tom v poslední době tolik nemluví. Už pomalu odeznívají hrozby toho, že dojde ropa a plyn a je potřeba hledat alternativní zdroje. Postupem času se však ukazuje, že se stále dají nalézat nová naleziště...

To je úplně jednoduché. Ve chvíli, kdy to začne docházet, tak ta cena vyletí tak vysoko, že se vyplatí hledat a využívat alternativní zdroje. Ty technologie už jsou dostupné, jen se to prostě nevyužívá. Kdybychom však šli do extrémů, tak ropa nikdy nedojde, protože poslední barel by byl tak drahý, že by se to nikomu nevyplatilo koupit. Ve chvíli, kdy to začne docházet, tak se to rychle projeví na ceně a přejde se na jinou technologii, na kterých se pracuje, a investují se do nich značné peníze. Zatím je však stále levnější využívat stávající technologie a zdroje. Takže vůbec nemám obavy o tom, že ropa nebo plyn dojdou. Jenom přejdeme na jinou technologii. Revoluční změna v energetice bude ve chvíli, kdy dojde k vytvoření nějakých baterií na skladování velkých objemů elektřiny. Dnes totiž nemůžete elektřinu nijak skladovat. A toto by změnilo obrovským způsobem celý světový trh energetiky. Ale to zatím není možné. Největší uskladnění elektřiny dnes máme ve vodních elektrárnách, ke kterým ale potřebujete mít vhodné přírodní podmínky. To ale není přesně to, co mám na mysli. Mluvím o relativně menší baterii, ve které by bylo možné skladovat velké množství elektřiny a využívat ji kdykoliv, kdy bude potřeba. Dnes se do této technologie investují obrovské peníze, a v Evropě je v tomto oboru předním investorem Německo, a i z toho důvodu, že se vydali cestou ne jadernou, ale cestou obnovitelných zdrojů energie, a to proto, že věří, že k tomu průlomu v této oblasti dojde.

Když nedojde, co bude potom Německo dělat? Po havárii ve Fukušimě se podle mě Německo unáhlilo v rozhodnutí postupně uzavřít všechny jaderné elektrárny na svém území. Asi ukáže čas, nakolik dobré či špatné rozhodnutí to bylo.

Je to jejich volba, a do vědy a výzkumu investují velké prostředky, na čemž podle mě nikdy nemůžou prodělat.

Ale když vám stojí jaderné elektrárny, ve kterých můžete vyrábět elektřinu za minimální náklady, a vy je nevyužíváte, tak to se vám přece nikdy nemůže vyplatit...

Ale pokud někdo přijde s takovouto baterií, tak se to vyplatí, a budete platit tomu, kdo s tím přišel. A navíc to stimuluje peníze do rozvoje těchto oblasti, a stimuluje to rozvoj ekonomiky v mnoha dalších oblastech. Já myslím, že to není pro Německo špatná volba. Samozřejmě, musí na to být zdroje, což se zdá, že v Evropě nejvíce zdroji oplývá právě Německo, musí na to být finanční, lidské a technologické kapacity, a to všechno v tom Německu je. Takže pro ně to nemusí být nutně špatné rozhodnutí. Jestli byli rozhodnuti uzavřít všechny elektrárny, tak je to jejich volba, mají na to bytostné právo. Když vláda věří tomu, že je schopna ty zdroje zajistit jinak, a evidentně tomu věří, tak proč ne.

Po uzavření jaderných elektráren v Německu se to ale přece musí projevit na ceně elektřiny...

Tak cena je deformovaná, podporou obnovitelných zdrojů. Samozřejmě, projeví se to na bezpečnosti sítě, protože ve chvíli, kdy nemáte jadernou elektrárnu jako vyrovnávací zdroj a máte jen výkon z obnovitelných zdrojů, a přestanete díky špatným klimatickým podmínkám dodávat elektřinu do sítě, tak vám reálně hrozí blackout. A potom musí nakupovat drahou elektřinu ze sousedních zemí, které ji většinou vyrábějí z jaderných elektráren. Z Francie nebo ČR. Takže tohle jim chybí. Je to ale o tom, najít si balanc v bezpečnosti, v ceně, a ochraně životního prostředí. A Německo se rozhodlo, že si to může dovolit. Vydali se cestou, která je pro ně dražší, ale ve výsledku může být efektivnější a může to tu ekonomiku nakopnout jinak, jestli přijdou opravu s nějakým průlomem v oblasti skladování elektřiny. To může ekonomiku nastartovat jiným způsobem, než kdyby se spokojili s tím, co mají. A je dobře, že to někdo dělá. Rozhodli se, že jsou ochotní do toho ty obrovské peníze dávat. My si to však dovolit nemůžeme, protože ty peníze nemáme. Až čas ukáže, jestli to bylo dobré nebo špatné rozhodnutí. Neodsuzoval bych to a priori, spíš bych to odsuzoval z toho pohledu, že udělali rozhodnutí, které ovlivnilo okolní státy, které tomu musely přizpůsobit svoje přenosové soustavy a sítě, bez konzultace s nimi.

Pro ČR to tedy znamená co?

Přetěžování našich sítí, které je třeba posílit. To ale souvisí s tím, že přenosové sítě v Německu nejsou úplně rozvinuté, mezi bývalým východním a západním Německem. To, že to rozhodnutí nebylo předem konzultované s dalšími zeměmi, a nebyly přijaté další kroky předtím, tak to možná mělo Německo udělat jinak. Ale má právo na to, neodsuzuju to.